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20. ABSTRACT (Continue on reverse side if necessary and identify by block number):

A preliminary model of the ambient atmosphere and ionosphere has been adopted for use in ROSCOE. The model provides at all altitudes all the needed properties of the neutral atmosphere, including a dependence on the solar cycle and the local (apparent) time for altitudes above 120 km. Analytic fit-functions to Myer's minor-species data base provide all the minor neutral species (O, CO_2, N, NO, H_2O, $O_2(^1\Delta g)$, 03, and NO_2) required by

next page

18. SUPPLEMENTARY NOTES (Continued)

EDITORS' NOTE

Volumes 13 to 17 were originally published by SAI to describe the atmospheric, geomagnetic, and high-altitude energy deposition and neutral heave models for ROSCOE. This whole section of code, when associated with an appropriate DRIVER subroutine, operated as a package that ran independently of the rest of the ROSCOE structure. Provision was also made, within this high-altitude package, for two completely independent descriptions of atmospheric heave, each with its own description of atmospheric chemistry.

When GRC incorporated this section of code within the ROSCOE framework, some modifications were necessary, which means that some of the descriptions in Volumes 13 to 17 are inappropriate to ROSCOE as it now exists. In particular, the NRL heave routines (deck NRLHYD) and associated chemistry (deck NRLCHM) are not presently used in ROSCOE. Three other subroutines are different: subroutines ATMOSU, EIF, and XTCOEF correspond to the ROSCOE subroutines ATMOS, EXPINT, and WDXP respectively. With these exceptions, the subroutines described in Volumes 13 to 17 correspond exactly to those currently in ROSCOE.

20. ABSTRACT (Continued)

cont.
the chemistry module. Interim electron density profiles and effective ion production rates serve as the basis for the ionospheric model. Herein are presented derivations, flow diagrams, Fortran listings, and test problems.

PREFACE

We thank R. W. Lowen for numerous helpful discussions and for pointing out the utility of — and providing — his early-ROSCOE versions of the AFWL WORRY-code routines JULIAN, SOLCY, ORB, and ZSOL which form the basis of the versions presented here; C. A. Smith for assistance in preparing Revision 02 of the ATMOSU program and an early version of this report; B. F. Myers for supplying the minor-species density-profiles used as a data base in Subroutine SPCMIN; and J. Wang for helpful suggestions.

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1. INTRODUCTION

In this volume we describe the model for the major and minor neutral species in the ambient atmosphere and the ambient ionosphere [ROSCOE Model 1]. The overall model consists of 11 subroutines of which three are major subroutines:

a. ATMOSU provides the major neutral species and the general properties of the ambient atmosphere,

b. SPCMIN provides the minor neutral species, and

c. IONOSU provides the ambient ionized species and the general properties of the ionosphere.

For simplicity in presentation, we have adopted flexible definitions of which species are major and which are minor. It is anticipated that the meaning will always be clear to the reader in the context of the usage.

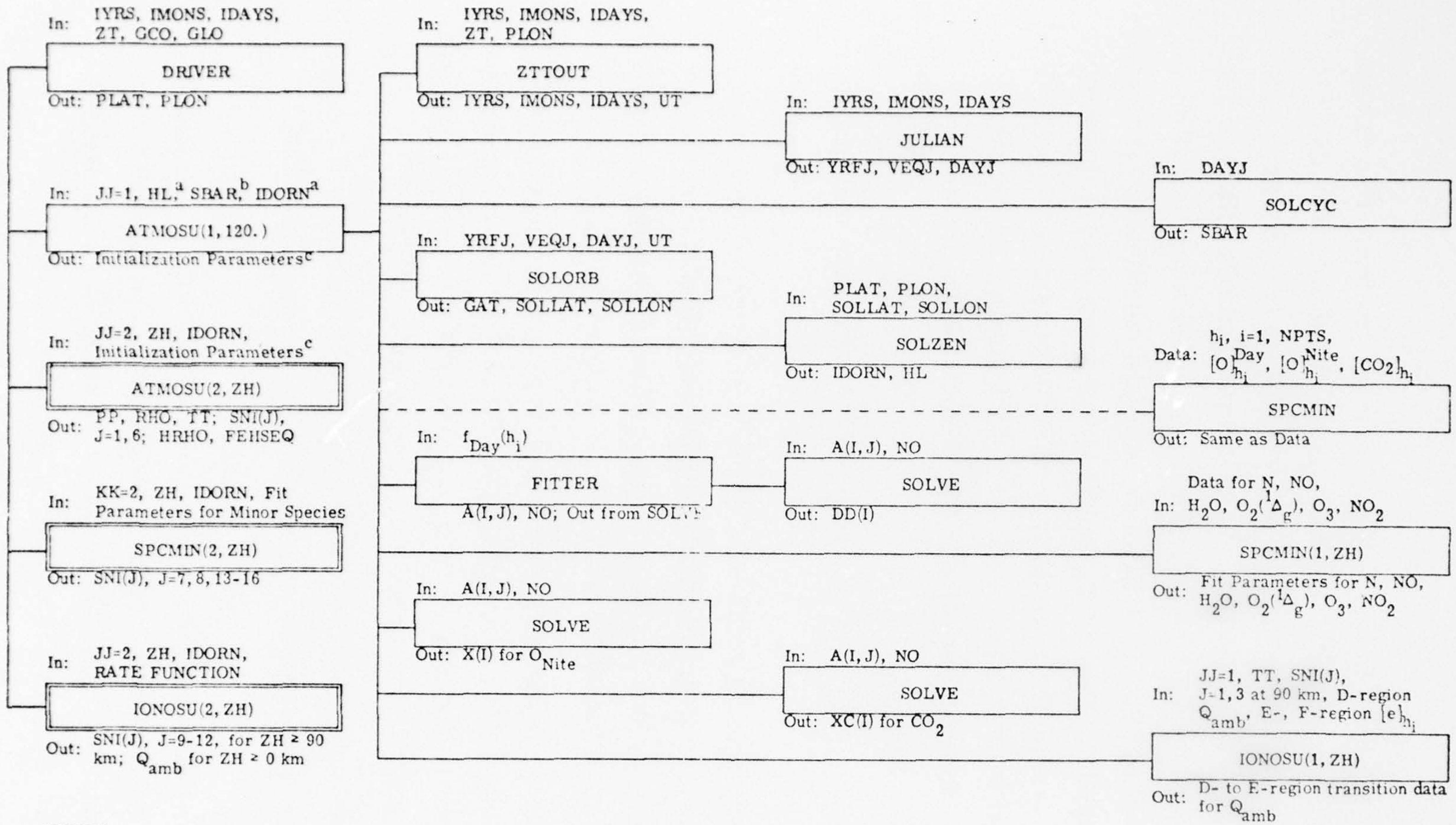
The overall inputs, some intermediate outputs, and final outputs for Model 1 are given in Table 1.

A flow diagram of the 11 subroutines, with their driver routine for development and test problem, is given in Fig. 1. A brief, simplified description of the working of the 11 subroutines follows.

The subroutine ATMOSU is initialized on a call to ATMOSU(1, 120.) to set up needed parameters and to evaluate the solar-flux-dependent Fourier coefficients used in computing the time-dependent values of τ (the variable controlling the temperature gradient at the lower boundary (120 km) of the high-altitude model) and T_∞ (the

Table 1. Inputs, Intermediate Outputs, and Final Outputs for Major and Minor Neutral Species and Ionosphere for Ambient Conditions (ROSCOE Model 1)

INPUTS	
Time:	Year, month, day, and zone time
Place:	Geographic colatitude and longitude; altitude
SOME INTERMEDIATE OUTPUTS	
Time:	Universal time, Julian day number, local (apparent) time, index for day or night
Solar-Cycle Property:	Solar flux at 10.7 cm
Minor Species:	Fit parameters for day and night density profiles
FINAL OUTPUTS	
Neutral Species:	N_2, O_2, O, Ar, He, CO_2, N, NO, NO_2, $O_2(^1\Delta_g)$, O_3, H_2O
Ionized Species (≥ 90 km):	e, O^+, M^+
Atmospheric Properties:	Pressure, density, density scale height, and (gas) temperature
Ionospheric Properties:	Electron (and N_2 vibration) temperature, effective ion-pair production rate



NOTES:

[a] Provided by SOLZEN.

[b] Provided by SOLCYC.

[c] Initialization parameters include:

(1) DD(I) for f_{Day}.
(2) PP, RHO, TT, HRHO, and SNI(6) at 120 km.
(3) Fourier coefficients for τ and T_∞.
(4) Coefficients for HRHO formula in 110- to 120-km interval.
(5) Coefficients for O_{Nite} profile.
(6) Coefficients for CO_2 profile in 100- to 120-km transition region.
(7) $[N_2(230\ km)] \equiv$ S1Z2N for N-profile initialization.
(8) Atmospheric profiles at 90-km for IONOSU initialization.

Fig. 1. Flow Diagram of ATMOSU, SPCMIN, IONOSU, and Their Auxiliary Subroutines.

exospheric temperature). In this call the values of the time (HL, hours), the 10.7-cm solar flux (SBAR), and the day-or-night parameter (IDORN) are determined by a series of calls from ATMOSU to five auxiliary subroutines (ZTTOUT, JULIAN, SOLCYC, SOLORB, and SOLZEN) and are passed to ATMOSU through ATMOUP Common. After an initialization call from ATMOSU to SPCMIN(1, ZH), daytime and nighttime fit parameters are determined for O and CO_2 and an initialization call is made to IONOSU(1, ZH). During the initialization of SPCMIN, six calls to FITTER and seven (direct) calls to SOLVE are made to determine the fit coefficients for the day and night profiles of the minor species NO, N, $O_2(^1\Delta_g)$, O_3, H_2O, and NO_2.

The working of the above-mentioned five auxiliary routines is as follows:

a. Subroutine ZTTOUT, receiving from TIME Common the input parameters year (IYRS), month (IMONS), day (IDAYS), and zone time (ZT) at east longitude PLON, returns to TIME Common the year, month, day, and mean or universal time (UT) at Greenwich.

b. Subroutine JULIAN, called with the input parameters of year (IYRS), month (IMONS), and day (IDAYS), returns the Julian day number at the first of the year (YRFJ), the Julian date for vernal equinox (VEQJ), and the Julian day number on the day of interest (DAYJ).

c. Subroutine SOLCYC, called with DAYJ, computes the average 10.7-cm solar flux (SBAR), an input to ATMOSU through ATMOUP Common.

d. Subroutine SOLORB, called with YRFJ, VEQJ, and DAYJ and receiving UT from TIME Common, computes the Greenwich apparent time GAT, placed in TIME Common, and returns the north latitude (SOLLAT) and east longitude (SOLLON) of the subsolar point.

e. Subroutine SOLZEN, called with SOLLAT and SOLLON and receiving PLAT, PLON, and GAT from TIME Common, computes IDORN and HL, inputs to ATMOSU through ATMOUP Common.

Subroutine FITTER, called from both ATMOSU and SPCMIN with values Y(I) of the dependent variable at NPTS values of the independent variable X(I), the degree NO of the polynomial used as the fitting function, an index IKIND denoting whether it is the dependent variable itself or its natural logarithm that is to be fitted, and an index ISIGN denoting negative or positive exponents in the polynomial, returns the polynomial coefficients determined by the method of least squares.

Subroutine SOLVE, called from Subroutines ATMOSU, SPCMIN, and FITTER with elements A(I, J) of a matrix of constant coefficients, returns the solutions of NO simultaneous linear algebraic equations.

The three major subroutines are ready for use after they have been initialized. On subsequent calls to ATMOSU(2, ZH), with ZH the altitude in kilometers, ATMOSU uses ATMOUP Common to return the pressure (PP), the mass density (RHO), the temperature (TT), the number densities of six species (SNI(I), I=1, 6), and the density scale height (HRHO). On subsequent calls to SPCMIN(2, ZH), ATMOUP Common is used to return the number densities of the six minor species (SNI(I), I=7, 8, 13-16). On subsequent calls to IONOSU(2, ZH), ATMOUP Common is used to return the number densities of the three charged species (SNI(I), I=9-11) and the electron (and N_2 vibration) temperature (SNI(12)) and IONOUP Common is used to return these same quantities (with different names) and the effective ion-production rate (QDEF).

2. AMBIENT ATMOSPHERE AND MAJOR NEUTRAL SPECIES

The main subroutine for the ambient atmosphere and the major neutral species is ATMOSU. It is based on the subroutine ATMOS developed by R. W. Lowen [Lo-73a]. For the convenience of the reader we have reproduced Lo-73a here as Section 2.1. Comments, revisions, and extensions to Lo-73a are given in Section 2.2. To facilitate finding the location in Lo-73a to which a comment or change in Section 2.2 applies, we have added an encircled letter (keyed to Section 2.2) at the appropriate location in the margin of the reproduced paper. The correspondence between symbols in Lo-73a (and in the revisions and extensions) and their Fortran names in ATMOSU is given in Section 2.3.

See Fig. 2 for a simplified flow diagram of ATMOSU and Table 2 for a summary of inputs and outputs for ATMOSU.

2.1 AN AMBIENT ATMOSPHERE MODEL FOR ROSCOE

(On pages 15-27)

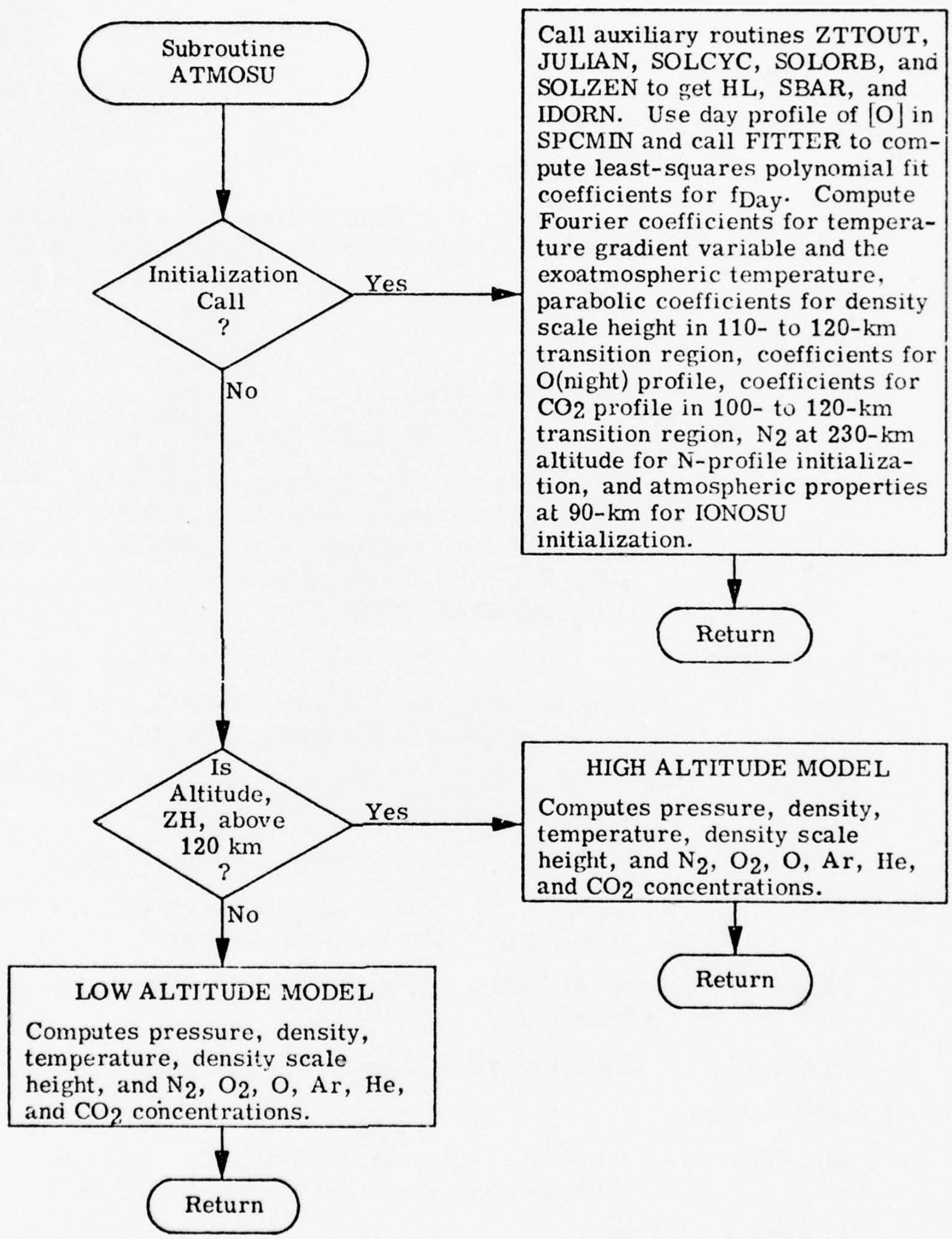


Fig. 2. Flow Diagram of ATMOSU Subroutine.

Table 2. Summary of ATMOSU Input/Output Variables.

INPUT VARIABLES

Argument List

JJ	-	Calculation flag If JJ = 1: calculate initialization parameters If JJ = 2: calculate atmospheric properties.
ZH	-	Altitude of interest (km).

ATMOUP Common

HL	-	Local time (hrs).
SBAR	-	Average 10.7-cm solar flux $[10^{-22}\ W/(m^2\ Hz)]$.
IDORN	-	Parameter for day or night. If COSCHI is the cosine of the zenith angle of the sun at point P, IDORN is 1 for daytime, i.e., IF(COSCHI.GE.0.0), and is -1 for nighttime, i.e., IF(COSCHI.LT.0.0).

TIME Common

IYRS	-	Number of the year in the 1900's (e.g., 1974 becomes 74) at east longitude PLON.
IMONS	-	Number of the month (e.g., February becomes 2) at east longitude PLON.
IDAYS	-	Day of the month at east longitude PLON.
ZT	-	Zone time for the 15-degree longitude interval containing PLON (decimal hours).
PLAT	-	North latitude of point P (say, grid origin) (radians).
PLON	-	East longitude of point P (say, grid origin).

ALTODN Common

NALTOD	-	Number of altitudes at which the daytime O-values are specified as data in SPCMIN.
ALTKM(47)	-	The array of altitudes at which minor species are specified as data in SPCMIN.

Table 2. (Continued).

ODAY(27)	-	The daytime O-values specified as data in SPCMIN.
ONITE(18)	-	The nighttime O-values specified as data in SPCMIN.
CO2(25)	-	The CO_2-values specified as data in SPCMIN.
OUTPUT VARIABLES		
ATMOUP Common		
PP	-	Pressure (dynes/cm^2)
RHO	-	Density (g/cm^3)
TT	-	Temperature (°K)
SNI(1)	-	N_2 concentration (1/cm^3)
SNI(2)	-	O_2 concentration (1/cm^3)
SNI(3)	-	O concentration (1/cm^3)
SNI(4)	-	Ar concentration (1/cm^3)
SNI(5)	-	He concentration (1/cm^3)
SNI(6)	-	CO_2 concentration (1/cm^3)
HRHO	-	Density scale height (km)
FEHSEQ	-	Fractional error in hydrostatic equilibrium
ALTODN Common		
S1Z2N	-	N_2 density at 230-km altitude for use in N-density initialization in SPCMIN

Lo-73a

AN AMBIENT ATMOSPHERE MODEL FOR ROSCOE

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Science Applications, Inc., La Jolla, California 92037

ABSTRACT

An initial computerized model of the ambient atmosphere has been developed for the ROSCOE code. The model reproduces within a few per cent all the data of the CIRA 65 atmospheres, extended smoothly to sea level in conformity with the U. S. Standard Atmosphere. The routine is fast and requires only 120 cards, yet has a sound physical basis, so that many continuous derivatives are provided and so that there is reason to believe the technique can be extended to newer atmospheric data as they become available. a*

1. INTRODUCTION

Science Applications, Inc. (SAI), has the responsibility for the development of the next-generation radar and optical systems code ROSCOE, with the General Research Corporation handling the systems aspects, under sponsorship of the Defense Nuclear Agency. It is intended that this development shall draw upon the phenomenology experience of the entire community. SAI must therefore take every opportunity to keep the community familiar with the status of ROSCOE development, and to solicit contributions, comments, and criticisms. Here we report on the status of one of the first phenomenology modules to be available in preliminary form, namely a model of the ambient atmosphere.

2. REQUIREMENTS OF THE MODEL

There are certain general requirements placed on all models for ROSCOE, such as high speed, low storage need, high accuracy, generality, high physics content, and smoothness. It is not always possible to achieve

*See Section 2.2 (p. 29ff) containing notes describing revisions.

all of these, but they are goals. Then there are specific requirements of the ambient atmosphere model. The ambient atmosphere routine is required to provide certain properties of the atmosphere when entered with values of altitude (≥ 0), latitude, local time, day number, and year (or equivalent parameter describing phase in the solar cycle). The desired outputs are species densities and temperatures, and various quantities that are determined by these, such as mass density, pressure, scale height, mean molecular weight, and so on. Outputs that are specifically excluded because they will be considered separately are the ambient ionosphere and ambient winds. Also excluded is tropospheric weather.

As for the general requirements on speed, accuracy, and storage, the first is not likely to be severe; it would be difficult to write an atmosphere routine that contributed seriously to overall ROSCOE running time, although called frequently. The accuracy requirement is first of all to reproduce atmospheric properties within their experimental uncertainties. This is not difficult, and turns out not to be the determining factor; rather, if the code purports to reproduce some atmosphere model in general use, it must do so with sufficient fidelity that the discrepancies produce no significant differences from other codings of the same model. We have interpreted this to mean that discrepancies should be no more than a few per cent in any quantity that is important.

The storage requirement, however, is a serious one, and all but eliminates certain kinds of models from consideration. Because atmospheric properties depend not only upon altitude but also (in various altitude regimes) on time of day, season, latitude, and solar cycle, and because so many output quantities are wanted, simple interpolation from tabular data would require very extensive tables (of course, not all would have to be in the machine at any one time).

The requirement of generality means primarily that we want to choose an adequate form for the preliminary model, although the details may change as newer data become available. This can be achieved provided the model has a sufficiently high physics content. Finally, the requirement of smoothness means that it is desirable for the output quantities to possess as many continuous derivatives as possible.

3. THE DATA BASE

It is expected that new CIRA (COSPAR International Reference Atmosphere) atmospheres will be issued shortly. Champion is preparing the high-altitude models, using the ideas of Jacchia's[1, 2] static diffusion models. Groves[3] is preparing the lower-altitude models. When these data become available, they will presumably represent a sufficient improvement over the data presently available that one will want to use them. At present, however, one can only proceed with what is in hand now, and try to select a model structure that can be readily adjusted to accept the new data. b

The older atmospheric data come from the CIRA 65 models[4] and the U. S. Standard Atmosphere[5], with the later models[6] of latitudinal and seasonal variations. Data on minor species are not provided in these sources, and generally have to be collected from the literature and collated; recent reviews by Strobel[7] and by Shimazaki and Laird[8] have been very helpful and provide many references.

Besides these data sets, the literature contains some examples of attempts at simplified modeling of high-altitude atmospheres. Deriving from an observation by Bates[9] that the equations describing an atmosphere in diffusive separation can be solved exactly analytically for a certain form of temperature profile, these models have been fitted to satellite data by Stein and Walker[10], to Jacchia atmospheres by Walker[11], and to CIRA 65 by Nisbet[12].

4. THE PRELIMINARY MODEL

A structure for the Ambient Atmosphere Model has been chosen that rests on a sound physical basis, that fits the currently-available[4, 5] data well, and that seems likely to be able to accommodate newer data as they come along. It is convenient to divide the discussion into three sub-topics, Major Species at Low Altitude, Major Species at High Altitude, and Minor Species.

4.1 Major Species at Low Altitude ($0 \le z \le 120$ km)

For the preliminary ambient atmosphere model we have elected to follow CIRA 65[4] in dividing the altitude regime into a low-altitude regime, $0 \le z \le 120$ km, wherein the major and inert species are thoroughly mixed so that fractional concentrations are (almost) altitude-independent, and a high-altitude regime where diffusive separation prevails (120 km $\le z$). Under these circumstances, the pertinent physics at low altitude comprises (a) hydrostatic equilibrium, (b) the perfect gas law, (c) the law of partial pressures, and (d) perfect mixing. Assumption (d) begins to fail above about 80 km altitude, because of solar dissociation of O_2, and somewhat higher because of increasing diffusion. The model can still be preserved by using as the defining quantity "molecular-scale temperature,"

$$T_M \equiv M_* T/M \ , \tag{1}$$

where

T = the true kinetic temperature ($^{\circ}$K),

M = the mean molecular weight,

M_* = the mean molecular weight at sea level = 28.96 g/mole.

This quantity is specified in both the CIRA 65 and U. S. Standard Atmospheres as a piecewise-linear profile, which permits the remaining equations to be

integrated analytically. There are two difficulties with this procedure. First, it does not satisfy our preference for an atmospheric model with continuous derivatives. Second, CIRA 65 is not defined below 30 km altitude; U. S. Standard is, but differs, although the two are fairly close near 40 or 50 kilometers.

To get around these two difficulties we have arbitrarily selected a profile of the quantity g/T_M, where g is the gravitational acceleration, that agrees with Ref. (5) below 30 km altitude, agrees with Ref. (4) above 50 km altitude, and more or less agrees with both between 30 km and 50 km altitudes. The chosen profile is shown in Fig. 1, along with the profiles defining the two atmospheres.

We have next fitted this profile as a least-squares polynomial in terms of the altitude, z(km). An eleventh-degree polynomial,

$$\frac{g}{T_M} = \sum_{k=0}^{11} g_k \, z^k \;, \tag{2}$$

fits to within a fraction of one per cent. The governing equations then yield the pressure,

$$p\ (\text{dynes/cm}^2) = p_o \exp\left[- \frac{M \quad 10^5}{R} \int_0^z \frac{g(z')}{T(z')}\, dz' \right] \tag*{c}$$

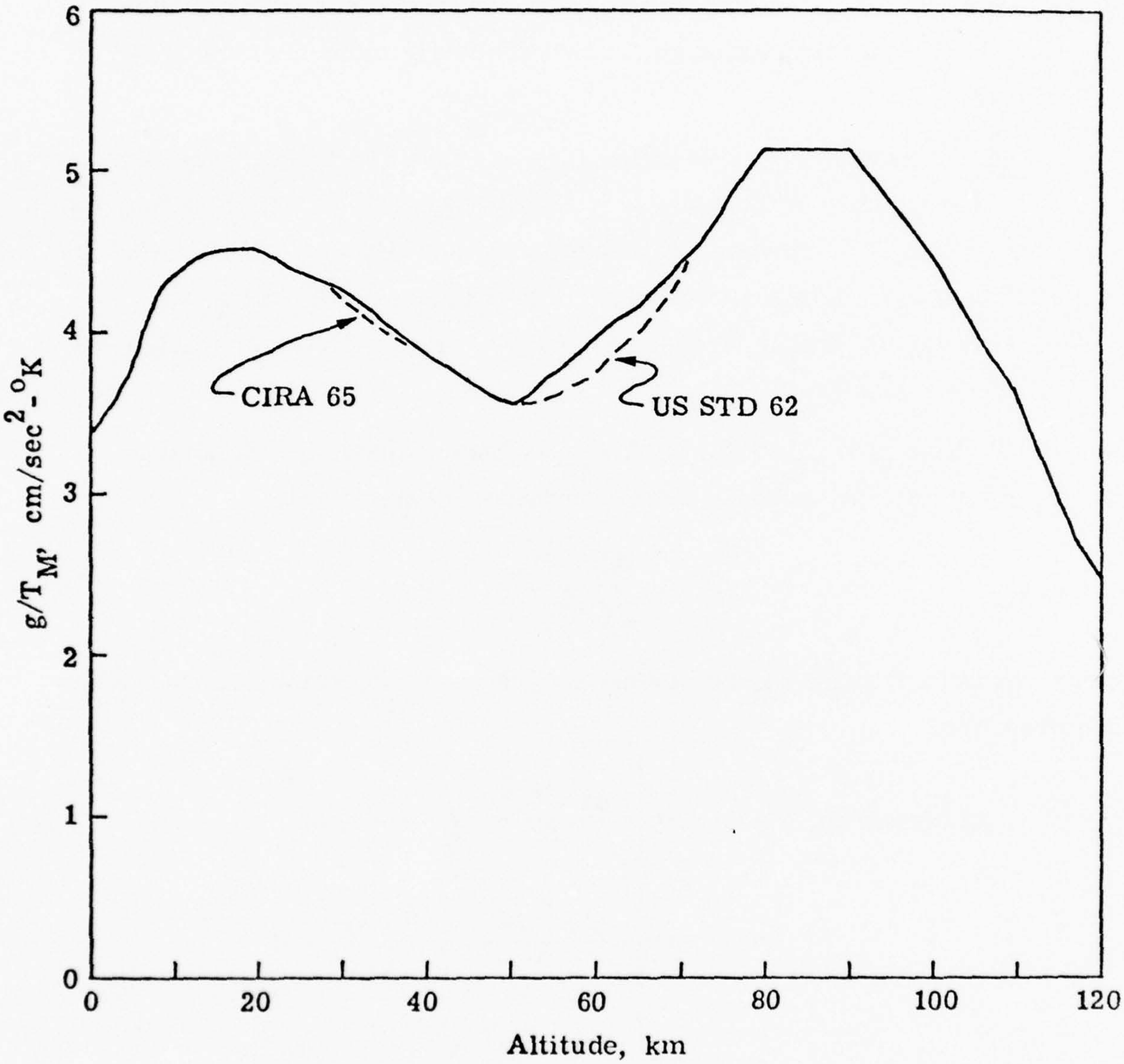
$$= p_o \exp\left[- \frac{M_* \quad 10^5}{R} \int_0^z \frac{g(z')}{T_M(z')}\, dz' \right]$$

$$= p_o \exp\left[- \frac{M_* \quad 10^5}{R} \sum_{k=0}^{11} \frac{g_k}{(k+1)}\, z^{k+1} \right] \;, \tag{3}$$

where

p_o = 1.01325 x 10^6 dynes/cm^2 (sea-level pressure),

R = 8.3143 x 10^7 erg/g-mole-^{o}K (universal gas constant).



(d) Figure 1. The Altitude Profile of Gravitational Acceleration Divided by Molecular-Scale Temperature Adopted to Define the Preliminary Ambient Atmosphere Model for $z \le 120$ km.

Because of biasing problems in this fitting procedure, the fit (3) does not provide an entirely adequate fit, especially at the important "join" altitude of 120 km. This can be fixed by multiplying the result (3) by a small correction,

$$p(x) = p_3(z) \exp[9.4144 \times 10^{-8} z^{2.833}] \ , \qquad (4)$$ e

where

p_3 = the value given by Eq. (3).

With the auxiliary equations

$$g = g_o R_e^2/(R_e + z)^2 \ , \qquad (5)$$

$$\rho = \left(\frac{M_*}{R}\right)\left(\frac{g}{T_M}\right)\left(\frac{p}{g}\right) \ , \qquad (6)$$

$$T = \left(\frac{M}{M_*}\right)\left(\frac{T_M}{g}\right) g \ ,$$

$$n = (\rho L) \Big/ \left[\left(\frac{M}{M_*}\right) M_*\right] \ , \qquad (7)$$

$$n_* = \rho L / M_* \ , \qquad (8)$$

$$[N_2] = 0.78 \, n_* \ , \qquad (9)$$

$$[A] = 0.009 \, n_* \ , \qquad (10)$$ f g

$$[O_2] = 1.211 \, n_* - n \ , \qquad (11)$$

$$[O] = 2n_* \left(\frac{M_*}{M} - 1\right) \ , \qquad (12)$$ h

$$[He] = 4.625 \times 10^{-5} \, n_* \ , \qquad (13)$$ i

this completes the low-altitude model, once M/M_* is specified. Here the symbols are:

g_o = sea-level gravitational acceleration = 980.621 cm/sec^2

L = Avogadro's number,

g = the acceleration of gravity (cm/sec^2) at altitude z,

R_e = the radius of a spherical earth = 6367.65 km,

ρ = mass density (g/cm^3),

T = kinetic temperature (^{o}K),

n = total number density (cm^{-3}),

n_* = total number density if no dissociation (cm^{-3}),

$[N_2]$ = number density of N_2 (cm^{-3}),

$[O_2]$ = number density of O_2 (cm^{-3}),

$[O]$ = number density of O (cm^{-3}),

j $[A]$ = number density of A (cm^{-3}),

$[He]$ = number density of He (cm^{-3}).

Note, please, that helium is included here among the "major species," where it clearly does not belong, because (a) it is necessary to provide a value at the join altitude of 120 km, and (b) its physics in the low atmosphere is probably more like that of the major species than like that of the minor ones.

The other problem facing the model has to do with M/M_*. The CIRA 65 description[4] is too vague to permit one to understand how the model was generated in the difficult region between 80 and 120 km altitudes, where solar dissociation of O_2 begins and where the importance of diffusion increases. Results consistent with CIRA 65 are obtained if one follows a procedure of (a) first calculating $[O_2]$ as at lower altitudes, and (b) then

dissociating some of the $[O_2]$, so that M/M_* decreases. This gives the equations

$$[O_2] + \frac{1}{2}[O] = 0.211\ n_* \tag{14}$$

$$[N_2] + [A] + [O_2] + [O] = n\ , \tag{15}$$

from which Eqs. (11) and (12) follow. Our model is completed by a fit to M/M_* of the form

$$M/M_* = 1/(1 + f)\ , \tag{16}$$

where f is the quantity given by the eighth-degree polynomial fit

$$f = \exp\left\{\sum_{k=0}^{8} f_k\, z^k\right\}\ ; \tag{17}$$ k

the data actually fitted were values of $M_*[O]/2L\rho$, with [O] taken from Ref. (4) above 80 km, from Ref. (8) for $40 \le z \le 80$ km, and artificially made to go to zero at $z = 0$. l

4.2 Major Species at High Altitude ($120\ \text{km} \le z$)

For the preliminary high-altitude model of the ambient atmosphere we have elected to adopt the Stein and Walker model(10) as adapted by Nisbet(12) to CIRA 65. Nisbet has given Fourier-series fits to the local-time variation of exospheric temperature and to the temperature gradient at 120 km altitude, with coefficients that depend on the value of the 10.7 cm solar flux. Using these, and with starting values at z = 120 km provided by the low-altitude model, one has the analytic solutions for species densities, m n

$$n_i(z) = n_i\,(120)\ \exp\left\{-\tau\gamma_i\zeta\right\}\left\{\frac{(1 - a)}{(1 - a\,e^{-\tau\zeta})}\right\}^{1+\alpha_i+\gamma_i}\ , \tag{18}$$

where

o $$\zeta = \frac{(z - 120)\, R_e^2}{(R_e + z)\,(R_e + 120)} \text{ (geopotential altitude)*} \quad , \tag{19}$$

p $$\gamma_i = m_i\, g/\tau k\, T_\infty \quad , \tag{20}$$

α_i = thermal-diffusion coefficient

= -0.4 for He, 0.0 for all other species considered,

$$a = (T_\infty - T_{120})/T_\infty \quad , \tag{21}$$

T_∞ = exospheric temperature ($^\circ$K) ,

T_{120} = temperature at 120-km altitude ($^\circ$K) ,

$n_i(120)$ = density of i^{th} species at 120-km altitude (cm^{-3}) ,

k = Boltzmann's constant (erg/$^\circ$K) ,

$$\tau = (T_\infty - T_{120})^{-1}\, (dT/dz)_{z=120} \quad , \tag{22}$$

m_i = mass of the i^{th} species (g/particle) .

From the results of (18)-(22), any other quantity of interest can be found, e.g., from the auxiliary equations

$$\rho = \sum_i n_i\, m_i \quad , \tag{23}$$

---

q *An incorrect equation for ζ is given in both Refs. (10) and (11).

$$p = kT \sum_i n_i \quad , \tag{24}$$

$$M = \rho \Big/ \sum_i n_i \quad , \qquad \text{etc.} \tag{25}$$

r

In the current model we have provided for N_2, O_2, O, A, and He. Because H has been neglected, the mass density given will be too low at extremely high altitudes. It is believed that this is an unimportant defect for present purposes; H can readily be added if it matters.

4.3 Minor Species

Besides the major species that contribute most to the overall number density, there are a number of minor species that are important to IR emission and transmission and other processes. These may include O_3, CO_2, OH, NO, CO, NO_2, N_2O, H_2O, HO_2, H, CH_4, HNO_3, and others. The basic experimental data on the altitude distribution of these species are sketchy at best; theoretical understanding can hardly be any better. Their distributions are believed to be governed by a combination of transport and chemical processes. The most elaborate calculations[8] consider only vertical transport, and have been sharply criticized[7] for both their boundary conditions and for their numerics.

In view of these difficulties, it was decided to defer modeling of the minor species until development of the chemistry and IR models has proceeded to the point where it is more clear just what is needed. Then a model will be provided using what data exist. Unfortunately, this model will undoubtedly have a weaker basis in physics than the major species models.

s

t

5. SUMMARY AND CONCLUSIONS

The preliminary ambient atmosphere model as described above has been programmed in FORTRAN for exercise and evaluation. The program has been used to calculate entire atmospheres for local times of 0, 4, 8, 12, 16, 20 hours and solar 10.7-cm flux values of 75, 150, and 225 $\times 10^{-22}$ watts/m^2 c/s (CIRA 65 Models 2, 5, and 8). Casual inspection shows that the results are correct everywhere to within a few per cent, except that in regions where a species is unimportant it may be given less accurately. Unfortunately, a very thorough comparison with the data-base models would have to be automated, and would involve a vast amount of keypunching atmosphere tables, so this has been foregone. It is also difficult to illustrate comparisons graphically when the quantities agree to a few per cent while varying over 17 orders of magnitude.

No special care has been taken to optimize this version for speed, since it is to be re-programmed at GRC for that purpose. Nevertheless, the current version gives results for a single altitude in about 1 msec on the CDC 7600.

It is clear that the preliminary model is still incomplete; lacking are (a) latitudinal and seasonal variations, (b) minor species models, (c) multi-temperature models, and (d) consideration of excited states. Work on (a) has been deferred pending receipt of the newer CIRA atmosphere models, expected soon. Work on (b), (c), and (d) has been deferred until work on the chemistry and IR models has proceeded far enough to establish a better definition of model requirements. Meanwhile, the preliminary model has been delivered to permit early running of the overall ROSCOE Code.

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2.2 COMMENTS, REVISIONS, AND EXTENSIONS TO LOWEN'S PAPER [Lo-73a]

a. **p. 15** The 120 cards in the original ATMOS (noted in the abstract) have increased to about 300 in Revision 09 of the Subroutine ATMOSU with an additional 300 substantive comment cards. The total number of cards in the deck (for ATMOSU, SPCMIN, IONOSU, their DRIVER, and their associated subroutines) is about 2318.

b. **p. 17** para. 2 CIRA-1972 [CI-72] has now been published.

c. **p. 19** In the first of Eqs. (3), M should appear as $M(z')$ in the integrand. The remaining equations are correct.

d. **p. 20** The analytic fit to the profile in Fig. 1 is given by Eq. (2).

e. **p. 21** In Eq. (4), read $p(z)$ instead of $p(x)$.

f. **p. 21** In Eq. (10), read [Ar] instead of [A].

g. **p. 21** The coefficient 0.009 in Eq. (10) is close to the value, 0.008615, required to reproduce the value given by CI-65 for [Ar] at 120 km, and it is also close to the value, 0.00934, given by US-62 for sea level composition.

h. **p. 21** In Eq. (12), note that the factor $[(M_*/M) - 1]$ equals the quantity f appearing in Eqs. (16) and (17).

i. **p. 21** The coefficient 4.625×10^{-5} in Eq. (13) is required to reproduce the value given by CI-65 for [He] at 120 km, but it is quite different from the value, 5.24×10^{-6}, given by US-62 for sea level composition.

j. **p. 22** Read Ar instead of A (twice).

k. p. 23 In Eq. (17), note that $M_*[O]/2L\rho = f$.

l. p. 23 para. 1 The [O]-values for $40 \le z(\text{km}) \le 80$ were taken from the noon, summer curve in Fig. 5 of Ref. 8. (Provision for day and night values of [O] is made in ATMOSU.)

m. p. 23 The Stein and Walker model assumes that the temperature profile is

$$T = T_\infty - (T_\infty - T_{120})\, e^{-\tau\zeta}. \tag{17a}$$

n. p. 23 Nisbet's Fourier-series fits to the local-time (HL) dependence of the exospheric temperature T_∞ and to the temperature gradient τ at 120-km altitude, with coefficients that depend on the value of the 10.7-cm solar flux (F) associated with the CIRA-1965 tables, are given by

$$T_\infty = \sum_{i=0}^{5} C_i(F) \cos\left(\frac{2\pi\, i\, HL}{24}\right) + \sum_{i=1}^{5} S_i(F) \sin\left(\frac{2\pi\, i\, HL}{24}\right) \tag{18a}$$

$$\tau = \sum_{i=0}^{5} A_i(F) \cos\left(\frac{2\pi\, i\, HL}{24}\right) + \sum_{i=1}^{5} B_i(F) \sin\left(\frac{2\pi\, i\, HL}{24}\right) \tag{18b}$$

Values of the coefficients are given in the computer program.

o. p. 24 Equation (19) should read

$$\zeta = \frac{1}{g_{120}} \int_{120}^{z} g\, dz' = \frac{(z - 120)(R_e + 120)}{R_e + z} \tag{19-Rev}$$

= geopotential altitude <u>above</u> 120 km.

p. p. 24 Equation (20) should read

$$\gamma_i = m_i \, g_{120} / \tau \, k \, T_\infty \tag{20-Rev}$$

q. p. 24 Delete footnote.

r. p. 25 Equation (25) should read

$$M = L\rho / \sum_i n_i \tag{25-Rev}$$

s. p. 25 Add Section 4.4, Density Scale Height.

By starting with the definition of density scale height,

$$H_\rho \equiv \rho(z)/(-d\rho/dz) \ , \tag{26}$$

and using the analytic expressions given in the paper, one finds that for the low-altitude model

$$H_\rho = \left[\frac{M_* \times 10^5}{R} \frac{g}{T_M} - \frac{1}{g/T_M} \sum_{k=1}^{11} g_k \, k \, z^{k-1} - 2.66710 \times 10^{-7} \, z^{1.833} - \frac{2}{R_e + z} \right] \tag{27}$$

and for the high-altitude model

$$H_\rho = \frac{\sum_i n_i(z) \, m_i}{\tau \left(\frac{R_e + 120 - \zeta}{R_e + z} \right) \sum_i n_i(z) \, m_i \left[\gamma_i + (1 + \alpha_i + \gamma_i) \frac{a e^{-\tau\zeta}}{1 - a e^{-\tau\zeta}} \right]} \ . \tag{28}$$

To provide a continuous density scale height across the boundary between the low- and high-altitude models, the following parabolic transition function can be used,

$$H_\rho(z) = a(z - 110)^2 + b(z - 110) + c , \qquad 110 \le z(\mathrm{km}) \le 120 \tag{29}$$

where

$c = H_\rho(110)$

b = derivative of density scale height at 110-km altitude, taken to be given by $[H_\rho(110.5) - H_\rho(109.5)]/1.0$.

$a = [H_\rho(120) - 10b - H_\rho(110)]/(120 - 110)^2$.

t. p. 25 Add Section 4.5, An Evaluation of the Departure from Hydrostatic Equilibrium.

The possible departure of the ROSCOE atmosphere from hydrostatic equilibrium is of interest, and we report our findings here.

4.5.1 Low-Altitude Model in ATMOSU

In the low-altitude portion of ATMOSU, the pressure, given by Eq. (3) of Lo-73a, is (initially) obtained by integrating the hydrostatic equation,

$$\frac{dp}{dz} = -\rho g . \tag{30}$$

However, owing to limitations in fitting g/T, a correction factor is used to obtain the final expression for the pressure,

$$p(Z) = p_3(Z)\, e^{A Z^b} , \tag{31}$$

where Z is in kilometers and

$$p_3(Z) = p_o \exp\left[- c \sum_{k=0}^{11} \frac{g_k}{k+1} Z^{k+1}\right] \tag{32a}$$

$$A = 9.4144 \times 10^{-8} \tag{32b}$$

$$b = 2.833 \tag{32c}$$

$$c = M_* \, 10^5/R \quad . \tag{32d}$$

To numerically test the extent to which the ATMOSU atmosphere departs from hydrostatic equilibrium, we evaluated the quantity

$$\text{FEHSEQ} \equiv \frac{-\,10^{-5}\,dp/dZ}{\rho g} - 1 \quad , \tag{33}$$

which is the fractional amount by which the acceleration at a point due to the pressure gradient fails to balance the acceleration due to gravity. By differentiating Eqs. (31) and (32a) and using Eqs. (2) and (6) of Lo-73a, one can rewrite Eq. (33) as

$$\text{FEHSEQ} = \frac{-\,10^{-5}\,A\,b\,Z^{b-1}}{g/T_M}\,\frac{R}{M_*} \quad . \tag{34}$$

The results of evaluating Eq. (34) are given in Section 4.5.3.

4.5.2 High-Altitude Models

The high-altitude model in ATMOSU is closely related to the CIRA-65 model [CI-65]. So, before examining the ATMOSU high-altitude model, we consider the CIRA-65 model.

4.5.2.1 CIRA-65 Model. One can test the departure of the CIRA-65 atmosphere from hydrostatic equilibrium by first noting that the pressure scale height, a quantity tabulated in CIRA-65, is defined by the expression

$$H_p \equiv \frac{p}{(-\,dp/dz)} \;, \qquad (35)$$

so that, if hydrostatic equilibrium obtains, the relation

$$-\frac{dp}{dz} = \frac{p}{H_p} = \rho g \qquad (36)$$

should be satisfied. The quantity FEHSEQ in Eq. (31),

$$\text{FEHSEQ} \equiv \frac{p}{H_p \rho\, g} - 1 \qquad \text{(cgs units)} \;, \qquad (37)$$

has the same meaning as in Eq. (33). An evaluation of Eq. (37) for the CIRA-65 Model-5 8-hr atmosphere shows that FEHSEQ varies from -9.96×10^{-4} at 120-km altitude to -6.53×10^{-3} at 800-km altitude. These errors are probably due to errors in numerical integration.

4.5.2.2 High-Altitude Model in ATMOSU. The ATMOSU high-altitude model is the Stein-Walker model as adapted by Nisbet to CIRA-65. To evaluate Eq. (33), one needs an expression for dp/dZ, which one can show, after considerable algebra, to be

$$\frac{dp}{dZ} = \frac{g\,\tau\,k\,T_\infty}{g_{120}} \left\{ a\,e^{-\tau\zeta} \sum_i n_i - \frac{T}{T_\infty} \sum_i n_i \left(\gamma_i + \frac{(1 + \alpha_i + \gamma_i)\,a\,e^{-\tau\zeta}}{1 - a\,e^{-\tau\zeta}} \right) \right\} . \qquad (38)$$

4.5.3 Numerical Results

For the low-altitude model in ATMOSU, one finds that the pressure derivative is too small to maintain hydrostatic equilibrium by a fractional amount that ranges from 0 at 0 km to 0.020 at 120-km altitude.

In the high-altitude model, for HL = 11.66 hrs and SBAR = 157.57, the pressure derivative is too small to maintain hydrostatic equilibrium by a fractional amount that increases from 9.0×10^{-6} at 120-km altitude to 1.0×10^{-4} at 320-km altitude and then decreases to 1.8×10^{-5} at 800-km altitude.

2.3 SYMBOLS IN LOWEN'S PAPER AND ITS EXTENSIONS AND THEIR FORTRAN NAMES IN ATMOSU

Symbol	Fortran	Definition
a	SA	Eq. (21).
$[Ar]$	SNI(4)	Argon number density.
A_i	A(I)	Fourier coefficient for τ.
B_i	B(I)	Fourier coefficient for τ.
C_i	C(I)	Fourier coefficient for T_∞.
f	SF SFDAF(ZH)	$M_*[O]/2L\rho$; see Eqs. (16) and (17). In ATMOSU, SFDAF(ZH) is used for the daytime profile of f.
f_k	DD(I)	Coefficient in polynomial fit to f, Eq. (17). In ATMOSU, DD(I) is used for the daytime profile of f.
F	FF SBAR	The 10.7-cm solar flux associated with the CIRA-1965 tables.

Symbol	Fortran	Definition
g	GG GAF(ZH)	Acceleration of gravity at altitude z.
g_o	GZ	Sea-level gravitational acceleration.
g_k	AA(I)	Coefficient in polynomial fit to g/T_M.
g/T_M	GDTM GDTMAF(ZH)	Ratio of g to T_M, Eq. (2).
$\int_0^z \frac{g(z')}{T_M(z')} dz'$	GDTMI GTMIAF(ZH)	Integral of g/T_M.
$\sum_1^{11} g_k\, k\, z^{k-1}$	GKKZ GKKZAF(ZH)	Derivative of g/T_M.
[He]	SNI(5)	Helium number density.
HL	HL	Local time, in hours.
H_ρ	HRHO	Density scale height.
$H_\rho(110)$	HRO110	Density scale height at $z = 110$ km.
$H_\rho(110.5)$	HR1105	Density scale height at $z = 110.5$ km.
$H_\rho(109.5)$	HR1095	Density scale height at $z = 109.5$ km.
$H_\rho(120)$	HRO120	Density scale height at $z = 120$ km.
$dH_\rho(110)/dz$	DDZ110	Derivative of density scale height at 110 km.
k	SK	Boltzmann's constant.
L	BIGA	Avogadro's number.
m_i	SMI(I)	Mass of species i.
M		Mean molecular weight.

Symbol	Fortran	Definition
M_*	BIGMS	Mean molecular weight at sea level.
M/M_*	BMBMS	Ratio of M to M_* for day (noontime) conditions.
n	SN	Total number density.
n_*	SNS	Total number density if no dissociation.
$n_i(z)$	SNI(I)	Number density of species i at altitude z.
$n_i(120)$	SNIZ(I)	Number density of species i at 120-km altitude.
$[N_2]$	SNI(I)	Molecular nitrogen number density.
[O]	SNI(3)	Atomic oxygen number density.
$[O_2]$	SNI(2)	Molecular oxygen number density.
p	PP	Pressure.
p_o	PZ	Sea-level pressure.
p_3		Basic factor in pressure, given by Eq. (3).
R	RR	Universal gas constant.
R_e	RE	Radius of a spherical earth.
S_i	S(I)	Fourier coefficient for T_∞.
T	TT	Kinetic temperature.
T_M		Molecular-scale temperature, Eq. (1).
T_{120}	TZ	Temperature at 120-km altitude.
T_∞	TIF	Exospheric temperature.
z	ZH	Altitude.

Symbol	Fortran	Definition
α_i	ALP(I)	Thermal-diffusion coefficient.
γ_i	GAM GAMT*SMI(I)	Eq. (20).
ζ	ZZ	Geopotential altitude (above 120 km).
π	PI	3.141592653590.
ρ	RHO	Mass density.
$d\rho/dz$	DRODZN	Spatial derivative of ρ.
τ	TAU	Variable controlling the temperature gradient at 120-km altitude, Eq. (22).

3. AUXILIARY SUBROUTINES FOR ATMOSU

The purpose of the five auxiliary subroutines ZTTOUT, JULIAN, SOLCYC, SOLORB, and SOLZEN is to convert inputs that are convenient for the user to the inputs required by ATMOSU, SPCMIN, and IONOSU. It is assumed the user will locate his coordinate system in space and time by stating the geographic north latitude and east longitude, the date, and zone time (based on 15-degree intervals of longitude) in a 24-hr system. These auxiliary routines determine the universal time, Julian day number, local (apparent) time, the solar zenith angle viewed from the origin, an index denoting day or night, and the 10.7-cm solar flux.

These subroutines (except ZTTOUT) had their origin in the AFWL WORRY code (where they were known as JULIAN, SOLCY, ORB, and ZSOL) and were revised when they were incorporated into the early-version ROSCOE code [LL-75]. These routines, to which ZTTOUT was added, were further revised and laden with comment cards under the contractual effort for the current ROSCOE code.

3.1 SUBROUTINE ZTTOUT

Subroutine ZTTOUT converts a Gregorian calendar date (specified by stating the year in the 20th century (IYRS), the month (IMONS), and the day (IDAYS)) and zone time (ZT) at a given east longitude (PLON) to the Gregorian calendar date and mean (or universal) time (UT) at Greenwich.

See Table 3 for a summary of inputs and outputs for ZTTOUT.

Table 3. Summary of ZTTOUT Input/Output Variables.

INPUT VARIABLES

Argument List

None

TIME Common

IYRS	-	Number of the year in the 1900's (e.g., 1974 becomes 74) at east longitude PLON
IMONS	-	Number of the month (e.g., February becomes 2) at east longitude PLON
IDAYS	-	Day of the month at east longitude PLON
ZT	-	Zone time for the 15-degree longitude interval containing PLON (decimal hours)
PLON	-	East longitude of point P (radians)

OUTPUT VARIABLES

Argument List

None

TIME Common

IYRS	-	A possibly revised value of the input parameter, corresponding to Greenwich
IMONS	-	A possibly revised value of the input parameter, corresponding to Greenwich
IDAYS	-	A possibly revised value of the input parameter, corresponding to Greenwich
UT	-	Universal time corresponding to the zone time ZT (decimal hours)

3.2 SUBROUTINE JULIAN

Subroutine JULIAN converts a Gregorian calendar date (specified by stating the year in the 20th century (IYRS), the month (IMONS), and the day (IDAYS)) to Julian day number (DAYJ) for use by Subroutine SOLORB.

See Table 4 for a summary of inputs and outputs for JULIAN.

Table 4. Summary of JULIAN Input/Output Variables.

INPUT VARIABLES

Argument List

IYRS	-	Number of the year in the 1900's (e.g., 1974 becomes 74) at Greenwich
IMONS	-	Number of the month (e.g., February becomes 2) at Greenwich
IDAYS	-	Day of the month at Greenwich

Common

None

OUTPUT VARIABLES

Argument List

YRFJ	-	Julian day number (a half integer) at 0 hrs UT on January 1 of the year of interest
VEQJ	-	Julian date for vernal equinox
DAYJ	-	Julian day number (a half integer) at 0 hrs UT on the day of interest

Common

None

3.3 SUBROUTINE SOLCYC

Subroutine SOLCYC computes the 10.7-cm solar flux (SBAR), an input to ATMOSU through ATMOUP Common, based on an assumed sinusoidal 11-year (or 4018-day) variation. The maximum value of 250 for SBAR, associated with Model 9 of the CIRA-65 atmosphere has been assigned the date of 1 June 1958. The minimum value of 65 for SBAR is associated with Model 1 of the CIRA-65 atmosphere.

See Table 5 for a summary of inputs and outputs for SOLCYC.

Table 5. Summary of SOLCYC Input/Output Variables.

INPUT VARIABLES

Argument List

DAYJ - Julian day number (a half integer) at 0 hrs UT on the day of interest

Common

None

OUTPUT VARIABLES

Argument List

None

ATMOUP Common

SBAR - Average 10.7-cm solar flux [1.0E-22 $W/(m^2\ Hz)$]

3.4 SUBROUTINE SOLORB

Subroutine SOLORB computes the north latitude (SOLLAT) and east longitude (SOLLON) of the apparent (actual motion) subsolar point, given the Julian day number at 0-hours UT on 1 January of the year of interest (YRFJ), the Julian date at which vernal equinox occurs (VEQJ), the Julian day number at 0-hours on the day of interest (DAYJ), and the universal time (UT).

See Table 6 for a summary of inputs and outputs for SOLORB.

Table 6. Summary of SOLORB Input/Output Variables.

INPUT VARIABLES

Argument List

YRFJ	-	Julian day number (a half integer) at 0 hrs UT on January 1 of the year of interest
VEQJ	-	Julian date for vernal equinox
DAYJ	-	Julian day number (a half integer) at 0 hrs UT on the day of interest

TIME Common

UT	-	Universal time corresponding to zone time ZT (decimal hours)

OUTPUT VARIABLES

Argument List

SOLLAT	-	North latitude of subsolar point (radians)
SOLLON	-	East longitude of subsolar point (radians)

TIME Common

GAT	-	Greenwich apparent time (decimal hours)

3.5 SUBROUTINE SOLZEN

Subroutine SOLZEN computes COSCHI, the cosine of the solar zenith angle at a point P, given the geographic north latitude (PLAT) and east longitude (PLON) of the point P and the north latitude (SOLLAT) and east longitude (SOLLON) of the subsolar point. The day-or-night parameter IDORN is +1 for daytime, i.e., if COSCHI $\geq$ 0.0, and is -1 for nighttime. The local apparent time (HL) is also computed from the Greenwich apparent time (GAT) and the east longitude of the point P (PLON).

See Table 7 for a summary of inputs and outputs for SOLZEN.

Table 7. Summary of SOLZEN Input/Output Variables.

INPUT VARIABLES

Argument List

SOLLAT	-	North latitude of subsolar point (radians)
SOLLON	-	East longitude of subsolar point (radians)

TIME Common

PLAT	-	North latitude of point P (say, grid origin) (radians)
PLON	-	East longitude of point P (radians)

OUTPUT VARIABLES

Argument List

None

ATMOUP Common

IDORN	-	Parameter for day or night. If COSCHI is the cosine of the zenith angle of the sun at point P, IDORN is 1 for daytime, i.e., IF(COSCHI.GE.0.0), and is -1 for nighttime, i.e., IF(COSCHI.LT.0.0)
HL	-	Local apparent time (decimal hours, e.g., 2230 hours becomes 22.50 hours)

4. MINOR NEUTRAL SPECIES

4.1 SUBROUTINE SPCMIN

The ROSCOE high-altitude chemistry module [Vol. 11] requires the minor neutral species O, CO_2, N, and NO. Analytic-fit profiles for day and night at all altitudes are provided for O and CO_2 in Subroutine ATMOSU. The profiles for N and NO are provided in Subroutine SPCMIN.

The ROSCOE low-altitude chemistry module [Vol. 11] requires in addition to O, CO_2, N, and NO, the minor neutral species H_2O, $O_2(^1\Delta_g)$, O_3, and NO_2, which are also provided by SPCMIN.

The inputs and outputs for SPCMIN are summarized in Table 8. The nature of the functions used for fitting the adopted data-base values [Vol. 14b] at noon or midnight in various altitude ranges is given in Tables 9 through 16 for O, CO_2, N, NO, H_2O, $O_2(^1\Delta_g)$, O_3, and NO_2.

Table 8. Summary of SPCMIN Input/Output Variables.

INPUT VARIABLES

Argument List

KK	-	Calculation flag = 1, calculate initialization parameters = 2, calculate atmospheric properties
ZH	-	Altitude of interest (km)

ATMOUP Common

IDORN	-	Index for day or night = +1, day = -1, night

(cont'd)

Table 8. (Continued).

ALTODN Common		
S1Z2N	-	N_2 density at 230-km altitude for use in N-density initialization.
DATA		
ALTKM(47)	-	Altitudes at which minor species densities are specified as data
NALTOD	-	Number of altitudes between 0 and 130 km used to establish the arithmetic function used for daytime O densities between 0- and 120-km altitude.
NALTND	-	Number of altitudes between 40 and 230 km used to fit the daytime N densities.
NDEGND	-	Degree of the polynomial used to fit daytime N densities between 40- and 230-km altitude.
NALTNN	-	Number of altitudes between 85 and 230 km used to fit the nighttime N densities.
NDEGNN	-	Degree of the polynomial used to fit nighttime N densities between 85- and 230-km altitude.
NALTNO	-	Number of altitudes between 0 and 120 km used to fit the daytime NO densities.
NDEGNO	-	Degree of the polynomial used to fit daytime NO densities between 0- and 120-km altitude.
NKMH2O	-	Number of altitudes between 0 and 120 km used to fit H_2O densities.
NDGH2O	-	Degree of the polynomial used to fit the H_2O densities between 0- and 120-km altitude.
NALTO2	-	Number of altitudes between 0 and 50 km used to fit daytime $O_2(^1\Delta_g)$ densities.
NDGO2D	-	Degree of the polynomial used to fit the daytime $O_2(^1\Delta_g)$ densities between 0- and 50-km altitude.
NKMNO2	-	Number of altitudes between 0 and 160 km used to fit the daytime NO_2 densities.

(cont'd)

Table 8. (Continued).

NDGNO2	-	Degree of the polynomial used to fit the daytime NO_2 densities between 0- and 160-km altitude.
ODAY(27)	-	Noontime data-base values of [O] at altitudes 0(5)130 km*
ONITE(18)	-	Midnight data-base values of [O] at altitudes 0(5)85 km *
CO2(25)	-	Data-base values of [CO_2] at altitudes 0(5)120 km *
ANODAY(25)	-	Noontime data-base values of [NO] at altitudes 0(5)120 km *
ANONIT(18)	-	Midnight data-base values of [NO] at altitudes 0(5)85 km*
ANDAY(47)	-	Noontime data-base values of [N] at altitudes 0(5)230 km *
ANNITE(47)	-	Midnight data-base values of [N] at altitudes 0(5)230 km *
O2SDGD(47)	-	Noontime data-base values of [$O_2(^1\Delta_g)$] at altitudes 0(5)230 km *
O2SDGN(47)	-	Midnight data-base values of [$O_2(^1\Delta_g)$] at altitudes 0(5)230 km*
O3DAY(27)	-	Noontime data-base values of [O_3] at altitudes 0(5)130 km*
O3NIT(27)	-	Midnight data-base values of [O_3] at altitudes 0(5)130 km*
H2ODN(25)	-	Data-base values of [H_2O] at altitudes 0(5)120 km*
SNO2D(33)	-	Noontime data-base values of [NO_2] at altitudes 0(5)160 km*
SNO2N(33)	-	Midnight data-base values of [NO_2] at altitudes 0(5)160 km*

*See Vol. 14b.

(cont'd)

Table 8. (Continued).

OUTPUT VARIABLES			
Argument List			
None			
ATMOUP Common			
SNI(7)	-	N	density, $1/cm^3$
SNI(8)	-	NO	density, $1/cm^3$
SNI(13)	-	$O_2(^1\Delta_g)$	density, $1/cm^3$
SNI(14)	-	O_3	density, $1/cm^3$
SNI(15)	-	NO_2	density, $1/cm^3$
SNI(16)	-	H_2O	density, $1/cm^3$
ALTODN Common			
NALTOD	-	See input	
ALTKM(47)	-	See input	
ODAY(27)	-	See input	
ONITE(18)	-	See input	
CO2(25)	-	See input (Note that the CO_2 densities from 0- to 100-km altitude are reset in Subroutine ATMOSU by using a constant mixing-ratio of 3.2×10^{-4}.)	

Table 9. Fit Functions for O Profiles.[a]

Altitude Range, km	Description
Day	
0-120	Not O but f is fitted by a 12th-degree polynomial
> 120	ATMOSU high-altitude model
Night	
0-60	Constant at data-point value
60-75	Exponential, with slope determined by data points at 60 and 75 km
75-90	5th-degree polynomial, to match data points at 75(5)85 km and daytime fit-function at 90 km and derivatives of 60-to-75-km fit-function at 75 km and daytime fit-function at 90 km
90-120	Daytime fit-function
> 120	ATMOSU high-altitude model

[a]Fits are made not in SPCMIN but in ATMOSU.

Table 10. Fit Functions for CO_2 Profile.

Altitude Range, km	Description
Day or Night	
0-100	Constant mixing ratio of 0.00032 in ATMOSU low-altitude model
100-120	6th-degree polynomial, to match ATMOSU low-altitude-model value at 100 km and data points at 105(5)120 km and derivatives of low-altitude-model function at 100 km and ATMOSU high-altitude-model function at 120 km
> 120	ATMOSU high-altitude model

Table 11. Fit Functions for N Profiles.

Altitude Range, km	Description
Day	
0-40	Constant at data-point value
40-230	8th-degree polynomial, determined by least squares for data points at 40(5)230 km
≥ 230	Proportional to N_2,[a] $[N] = \left\{[N]/[N_2]\right\}_{230} [N_2]$
Night	
0-85	Constant at data-point value
85-230	6th-degree polynomial, determined by least squares for data points at 85(5)230 km
≥ 230	Proportional to N_2,[a] $[N] = \left\{[N]/[N_2]\right\}_{230} [N_2]$

[a]This procedure makes [N] dependent on the time to the extent that $[N_2]$ is dependent on the time.

Table 12. Fit Functions for NO Profiles.

Altitude Range, km	Description
	Day
0-120	12th-degree polynomial, determined by least squares for data points at 0(5)120 km
120-125	Parabolic transition function, determined by the 120-km data point, the derivative at 120 km (estimated by using the daytime fit-function values at 115 and 120 km) and a prescribed value at 125 km. (The 125-km value is determined by the requirement that the slope of the function be continuous at 125 km. See Vol. 14b.)
> 125	Exponential, determined by the prescribed value at 125 km and a solar-flux dependent value at 215 km.
	Night
0-50	Constant at data-point value
50-55	Exponential, determined by data points at 50 and 55 km
55-85	8th-degree polynomial, to match data points at 55(5)80 km, daytime fit-function value at 85 km, and derivatives of 50-to-55-km fit function at 55 km and daytime fit-function at 85 km
85-100	Daytime fit-function
> 100	A prescribed altitude-dependent fraction of the daytime fit function

Table 13. Fit Functions for H_2O Profile.

Altitude Range, km	Description
Day or Night	
0-120	12th-degree polynomial, determined by least squares for data points at 0(5)120 km
≥ 120	Exponential, $[H_2O] = [H_2O]_{120} \exp[-0.166(h - 120)]$, where $[H_2O]_{120}$ is determined from the fit function from 0 to 120 km.

Table 14. Fit Functions for $O_2(^1\Delta_g)$ Profiles.

Altitude Range, km	Description
Day	
0-50	10th-degree polynomial, to match data points at 0(5)50 km
50-75	Exponential, determined by data points at 50 and 75 km
75-90	5th-degree polynomial, determined by data points at 75(5)90 km and derivatives of 50-to-75 km fit-function at 75 km and ≥ 90-km fit-function at 90 km
≥ 90	Exponential, determined by data points at 90 and 105 km
Night	
0-70	Constant at data-point value
70-80	Exponential, determined by data points at 70 and 80 km
80-100	5th-degree polynomial, determined by data points at 80(5)95 km and values of daytime fit-function and its derivative at 100 km
≥ 100	Daytime fit-function

Table 15. Fit Functions for O_3 Profiles.

Altitude Range, km	Description
	Day
0-40	9th-degree polynomial, to match data points at 0(5)40 km and derivative of 40-to-75-km fit-function at 40 km
40-75	Exponential, determined by data points at 40 and 75 km
75-90	5th-degree polynomial, to match data points at 75(5)90 km and derivatives of 40-to-75-km fit-function at 75 km and ≥ 90-km fit-function at 90 km
≥ 90	Exponential, determined by data points at 90 and 105 km
	Night
0-55	Daytime fit function
55-70	5th-degree polynomial, to match daytime fit-function at 55 km, data points at 60(5)70 km, and derivatives of 0-to-55-km fit-function at 55 km and 70-to-75-km fit-function at 70 km
70-75	Exponential, determined by data points at 70 and 75 km
75-90	5th-degree polynomial, to match data points at 75(5)90 km and derivatives of 40-to-75-km fit-function at 75 km and ≥ 90-km fit-function at 90 km
≥ 90	Exponential, determined by data points at 90 and 105 km

Table 16. Fit Functions for NO_2 Profiles.

Altitude Range, km	Description
	Day
0-160	12th-degree polynomial, determined by least squares for data points at 0(5)160 km
> 160	Exponential, with slope determined by fit-function values at 140 and 160 km, and passing through fit-function value at 160 km
	Night
0-55	$[NO_2]_{night} = [NO]_{day} + [NO_2]_{day} - [NO]_{night}$
55-65	Exponential, with slope determined by fit function at 55 km, and passing through data point at 65 km
65-82	Exponential, with slope determined by data point at 65 km and by daytime fit-function value at 82-km altitude
> 82	Daytime fit function

4.2 AUXILIARY SUBROUTINES

A brief description of the operation of Subroutines FITTER and SOLVE is given in Section 1.

4.2.1 Subroutine FITTER

A summary of inputs and outputs for Subroutine FITTER is given in Table 17.

4.2.2 Subroutine SOLVE

A summary of inputs and outputs for Subroutine SOLVE is given in Table 18.

Table 17. Summary of FITTER Input/Output Variables.

INPUT VARIABLES

Argument List

NPTS	-	Number of data points
X(I)	-	Values of the independent variable, e.g., altitude (km)
Y(I)	-	Values of the dependent variable, e.g., species concentration (cm^{-3})
NO	-	Degree of polynomial to be fitted.
IKIND	-	Index for kind of equation to be fitted.
		= 1 if equation is $\ln(Y) = \sum_{n=0}^{NO} A_n X^n$
		= 2 if equation is $Y = \sum_{n=0}^{NO} A_n X^n$
ISIGN	-	Index for sign of exponents
		= 1 for negative exponents
		= 2 for positive exponents

Common

None

OUTPUT VARIABLES

Argument List

Z(J)	-	The least-squares fit coefficients. Z(1) corresponds to A_0, Z(2) to A_1, etc.

Common

None

Table 18. Summary of SOLVE Input/Output Variables.

INPUT VARIABLES		
Argument List		
A(I, J)	-	Element (I, J) of matrix of constant coefficients for NO simultaneous linear algebraic equations
NO	-	The number of equations
Common		
None		
OUTPUT VARIABLES		
Argument List		
X(K)	-	The least-squares fit coefficients. These are the same as the output Z(K) from FITTER and the same as DD(K) in ATMOSU.

4.3 PLOTS OF MINOR NEUTRAL SPECIES PROFILES

Comparisons of the fit-function values with the data-base values [Vol. 14b] of minor species densities are given in Figs. 3 through 10. Broken lines (solid for noon, dashed for midnight) connect data-base values at 5-km intervals. Circles represent fit-function values at 5-km intervals.

Plots of day and night values for five of the minor species densities of interest in the D region appear in the very recently published handbook by Knapp and Schwartz [KS-75, Fig. 8-1], reproduced here as Fig. 11. To aid in comparing our results with the handbook results, we have used their scales to replot our fit functions for the same species, shown in Fig. 12.

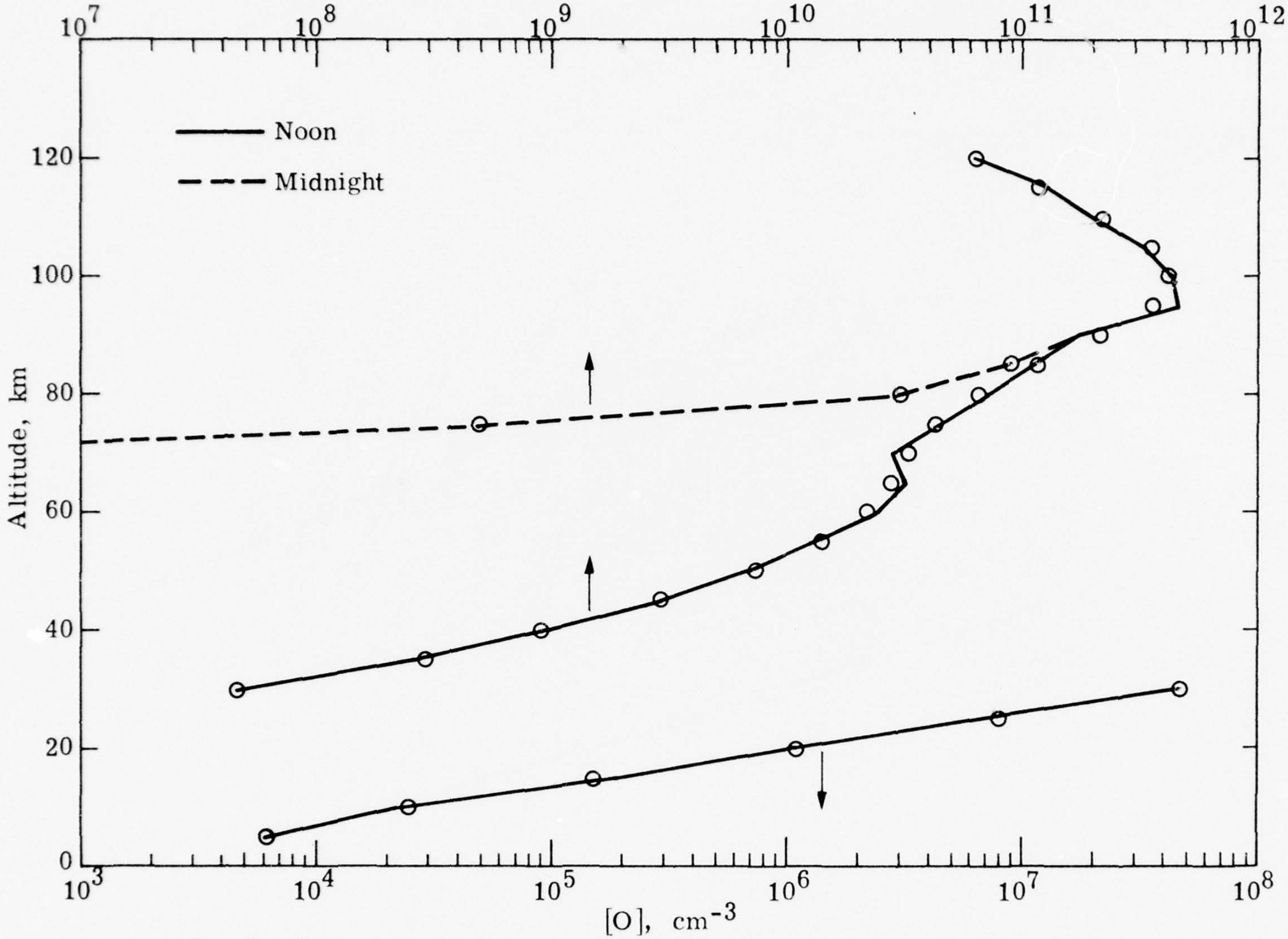

Fig. 3. O Density Profile. The ATMOSU-computed fit-function profile is shown with the adopted data-base profile [My-75].

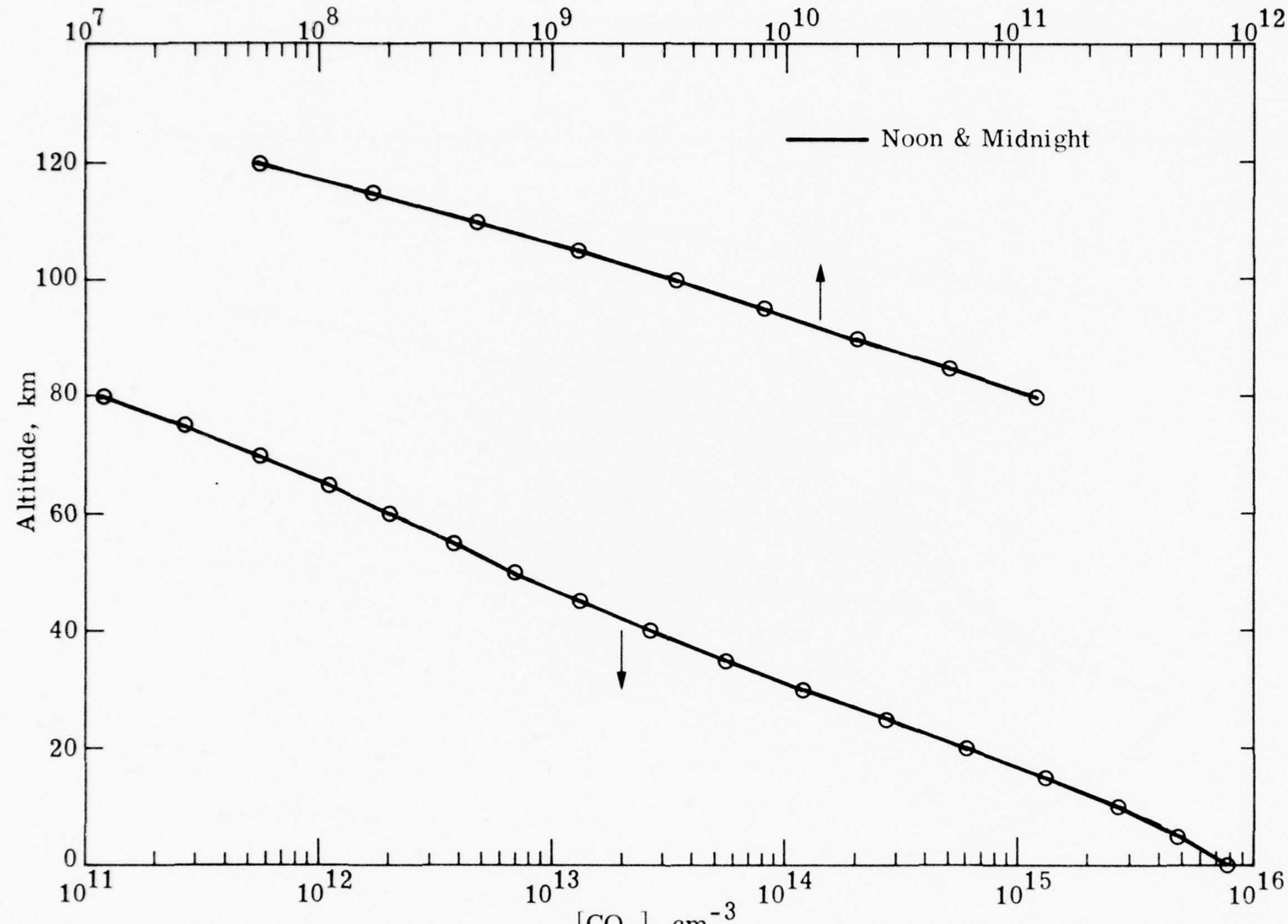

Fig. 4. CO_2 Density Profile. The ATMOSU-computed fit-function profile is shown with the adopted data-base profile [My-75].

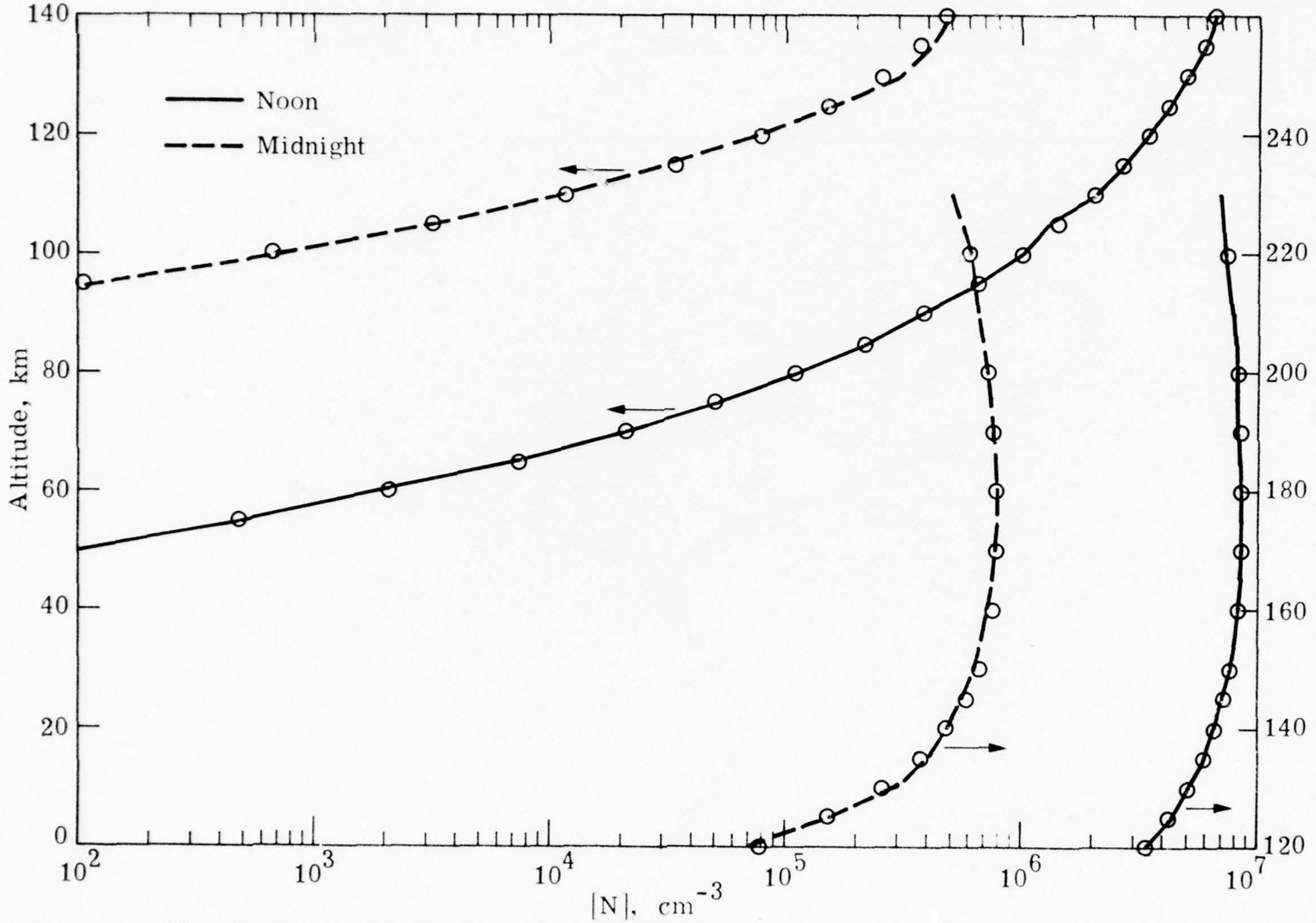

Fig. 5. N Density Profile. The SPCMIN-computed fit-function profile is shown with the adopted data-base profile [My-75].

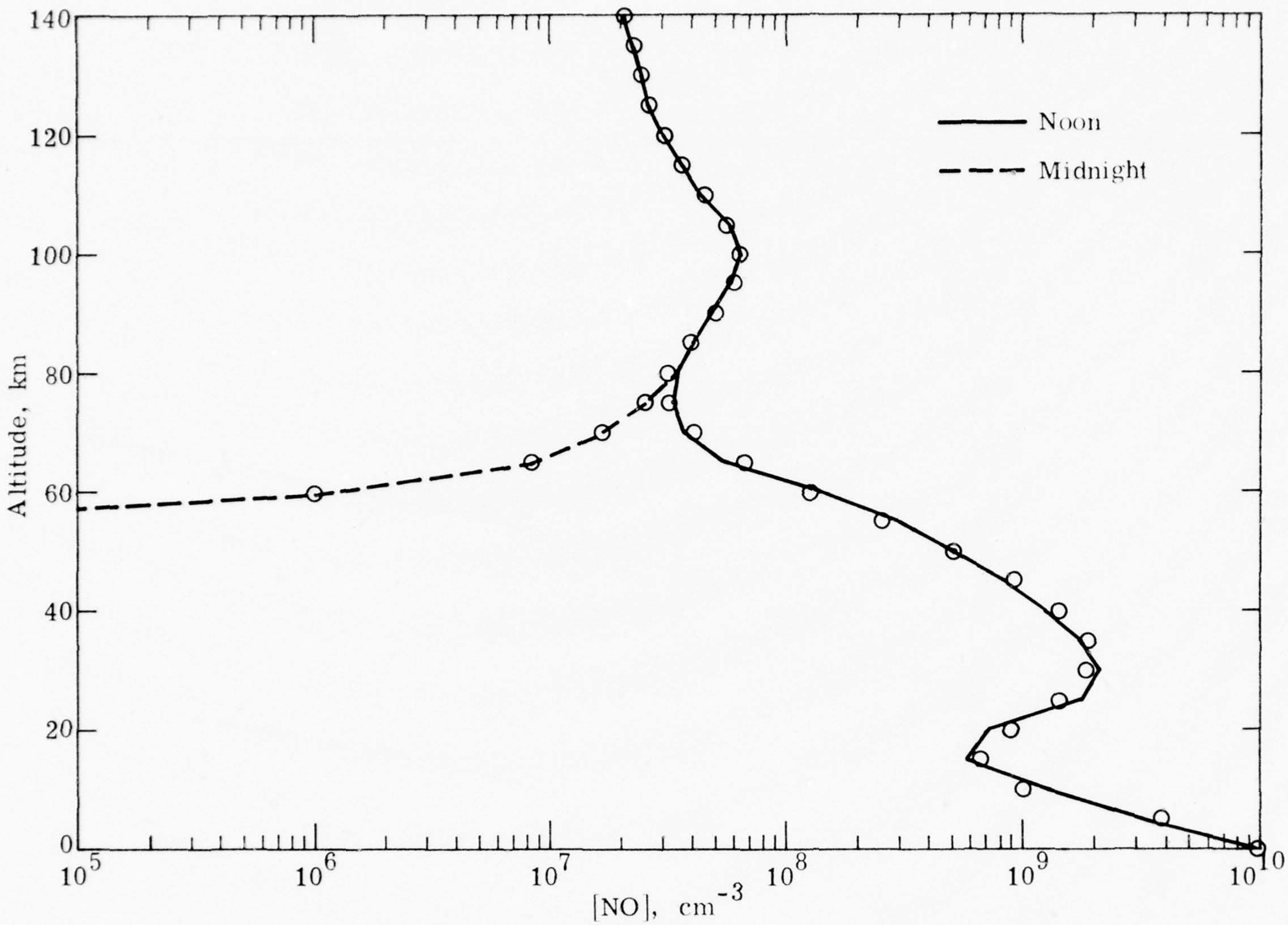

Fig. 6. NO Density Profile. The SPCMIN-computed fit-function profile is shown with the adopted data-base profile [My-75].

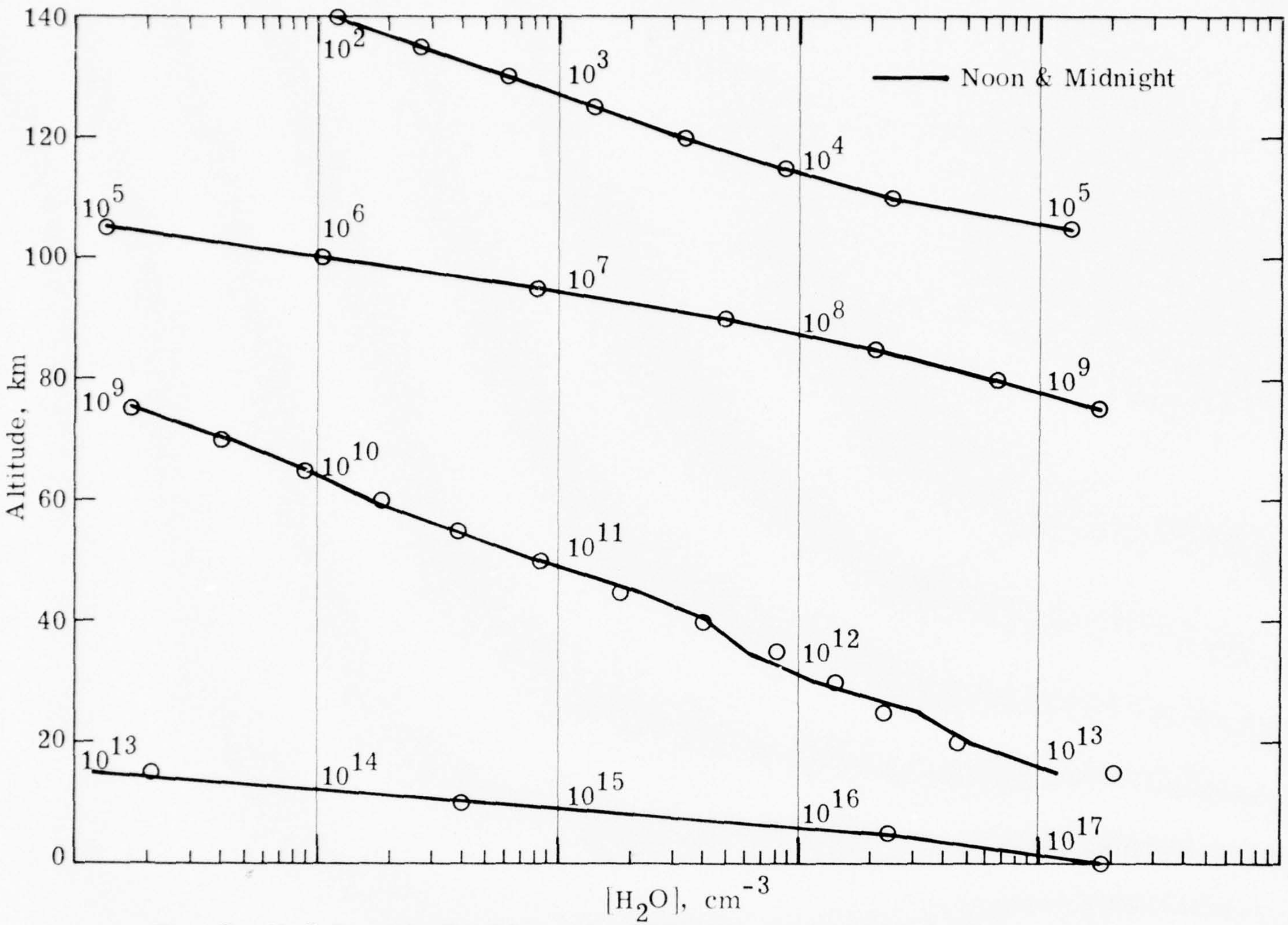

Fig. 7. H_2O Density Profile. The SPCMIN-computed fit-function profile is shown with the adopted data-base profile [My-75].

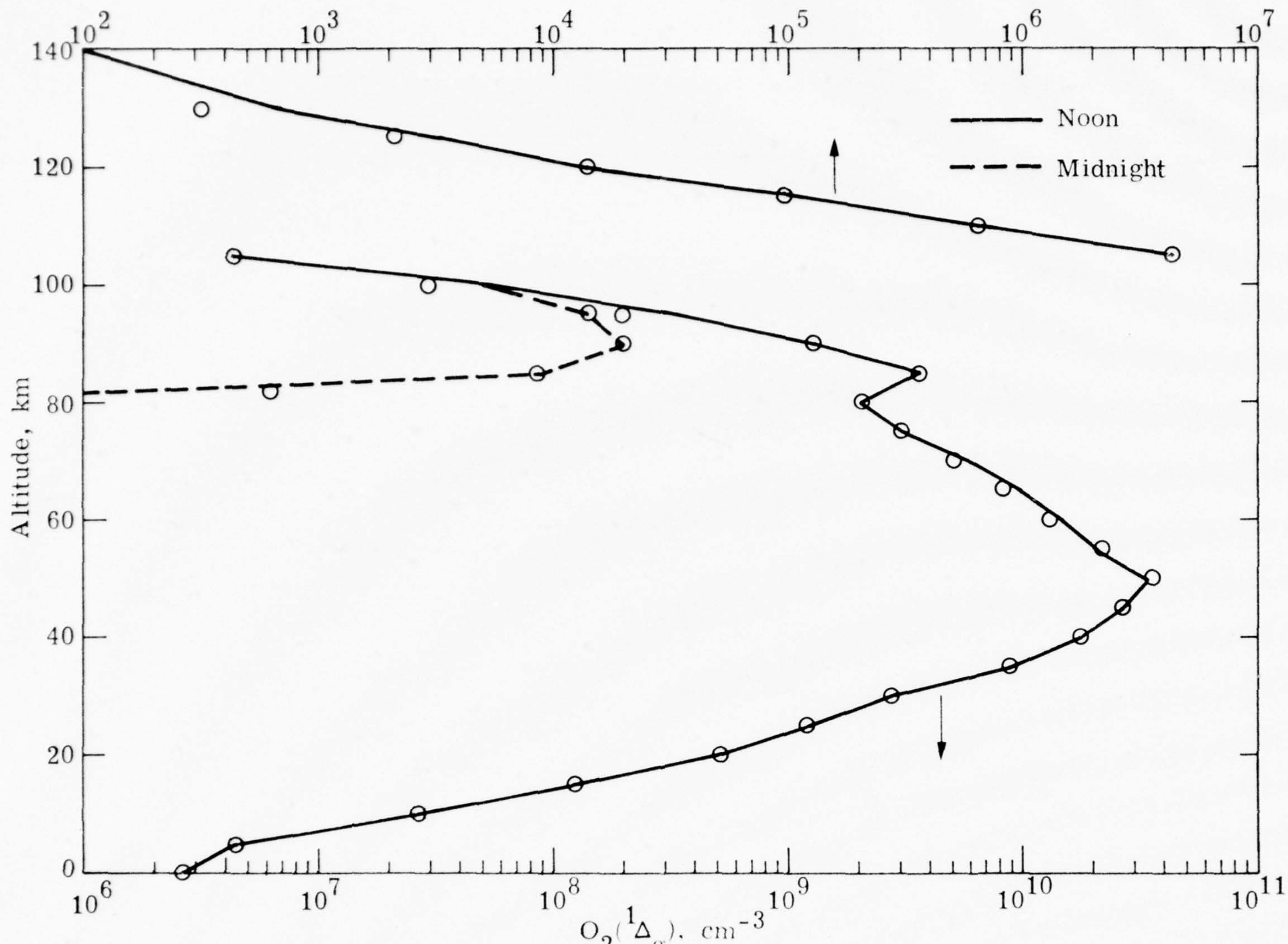

Fig. 8. $O_2(^1\Delta_g)$ Density Profile. The SPCMIN-computed fit-function profile is shown with the adopted data-base profile [My-75].

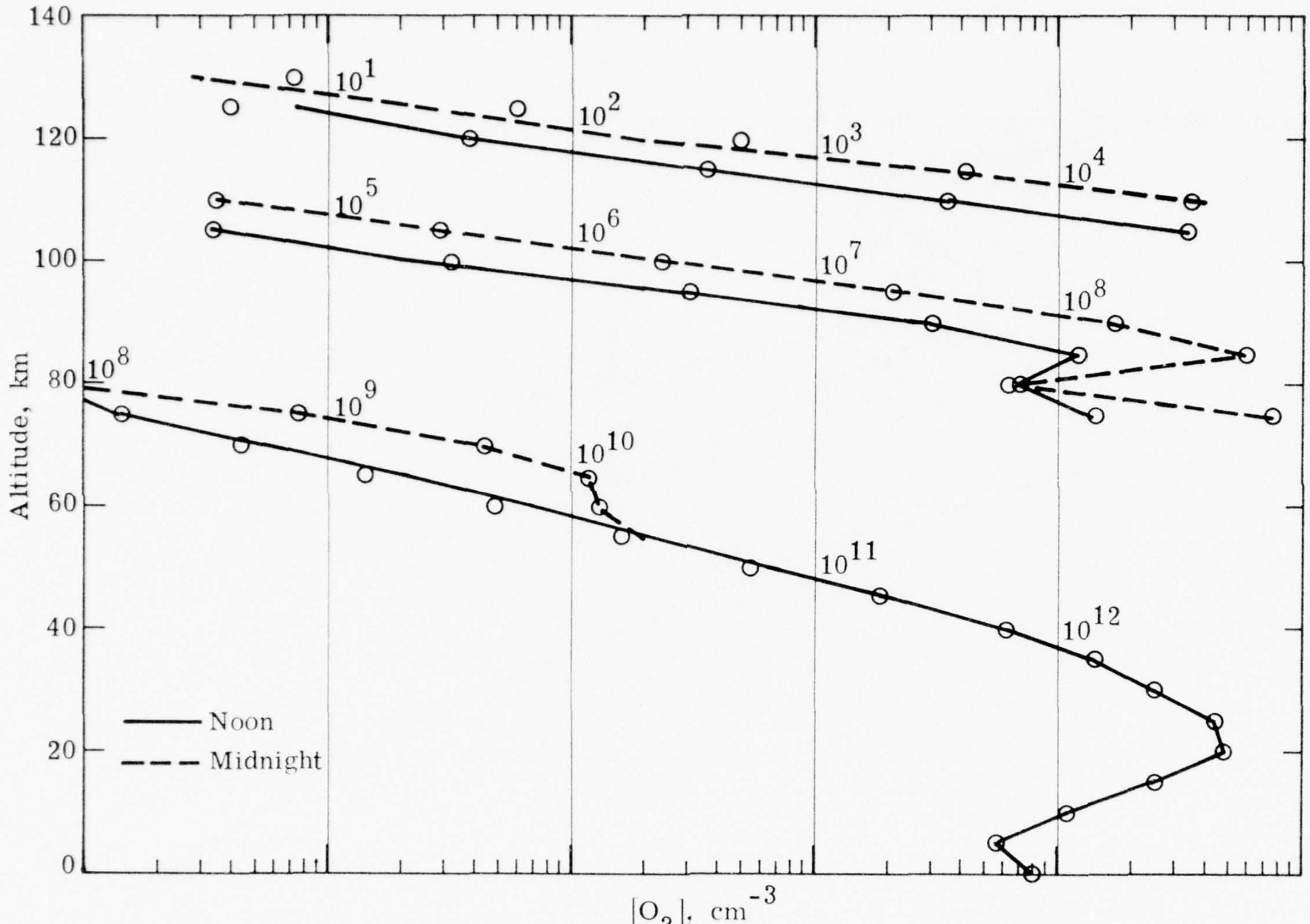

Fig. 9. O3 Density Profile. The SPCMIN-computed fit-function profile is shown with the adopted data-base profile [My-75].

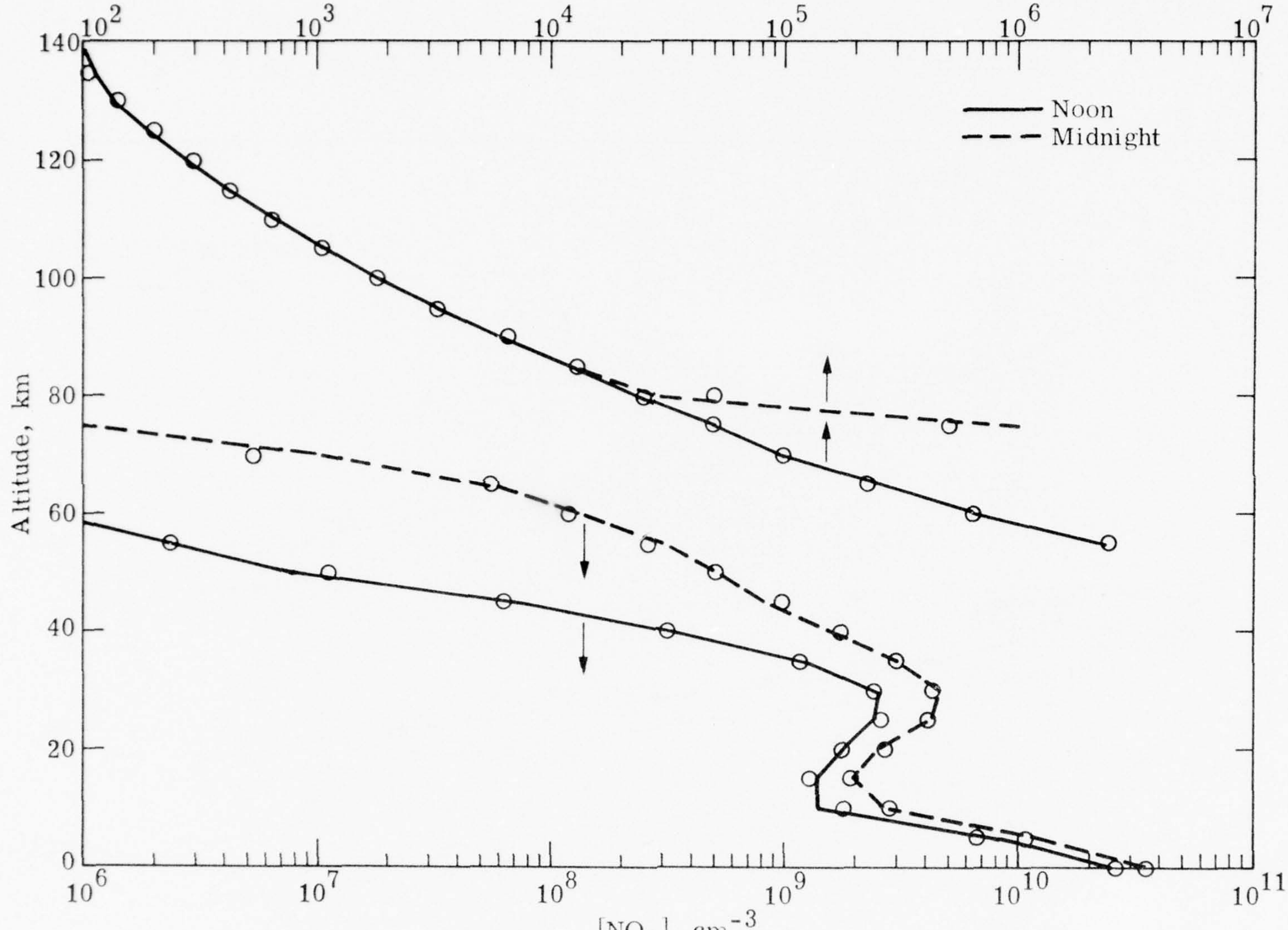

Fig. 10. NO_2 Density Profile. The SPCMIN-computed fit-function profile is shown with the adopted data-base profile [My-75].

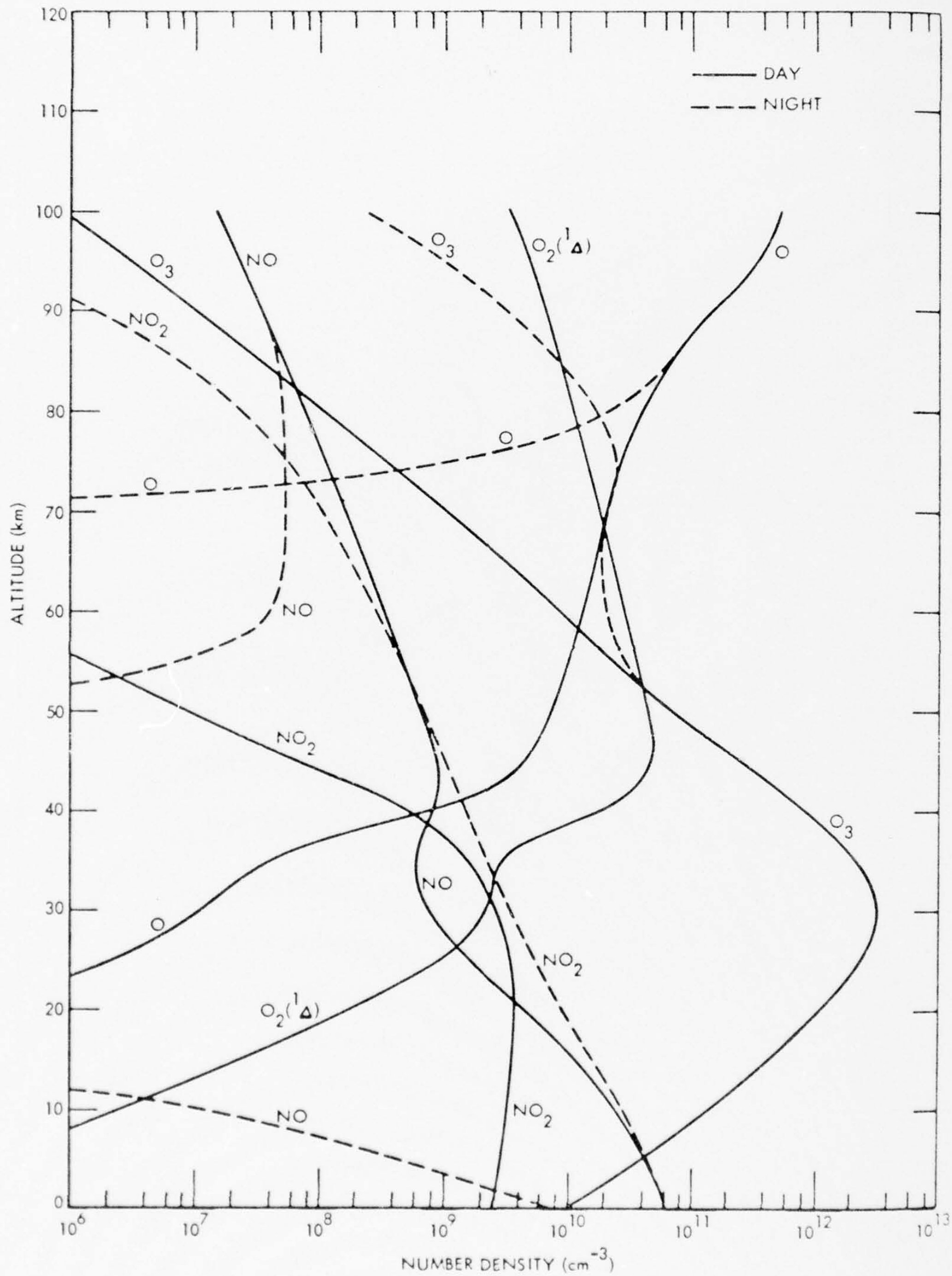

Fig. 11. D-Region Minor Neutral-Species Profiles from KS-75 (Fig. 8-1).

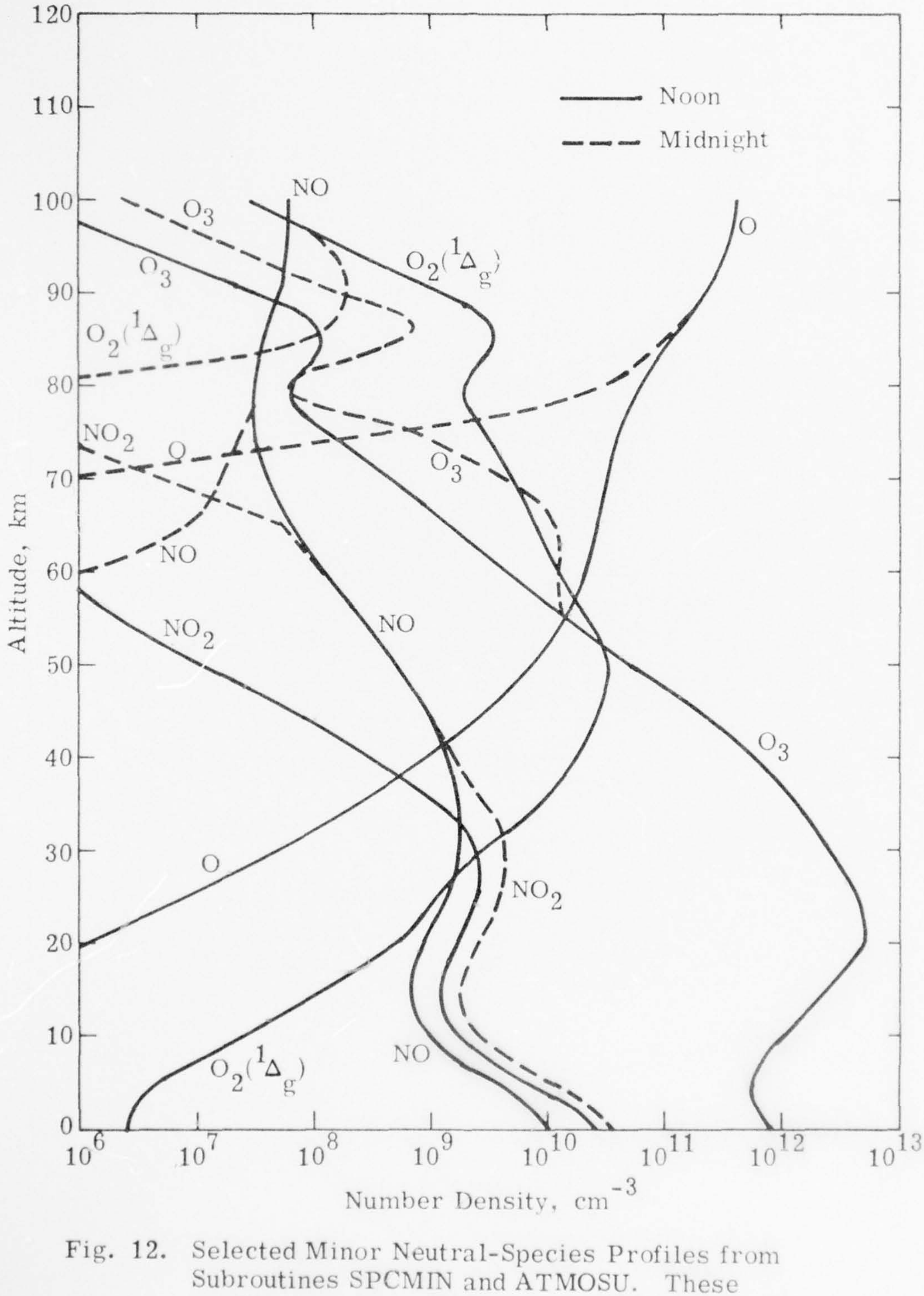

Fig. 12. Selected Minor Neutral-Species Profiles from Subroutines SPCMIN and ATMOSU. These profiles may be compared with those in Fig. 11.

5. AMBIENT IONOSPHERE (SUBROUTINE IONOSU)

See Table 19 for a summary of inputs and outputs for IONOSU.

5.1 E- AND F-REGION IONOSPHERIC PROPERTIES

The E- and F-region chemistry module requires the following quantities:

a. q, the effective total ion production rate that reproduces the ambient ionosphere when used with the chemistry model ($cm^{-3}\ sec^{-1}$)

b. O^+, the positive atomic-ion density (cm^{-3})

c. M^+, the positive molecular-ion density (cm^{-3})

d. T_x, the electron and (N_2 vibration) temperature (°K)

RANC IV uses unsatisfactory steady-state formulas [GE-70, Eqs. (2-276), (2-274), and (2-275)] for q, O^+, and M^+. The derivation [GE-70] of the RANC IV equations is incomplete because there are a number of tacit, (unnecessary) simplifying assumptions. The exact solutions may be derived as follows.

Equations (2-270) and (2-271) of GE-70, for steady-state conditions, become

$$[\dot{O}^+] = 0 = q_1 - \beta[O^+] - \alpha_r[O^+]\left\{[O^+] + [M^+]\right\} \tag{1}$$

$$[\dot{M}^+] = 0 = q_2 + \beta[O^+] - \alpha_d[M^+]\left\{[O^+] + [M^+]\right\} , \tag{2}$$

Table 19. Summary of IONOSU Input/Output Variables.

INPUT VARIABLES

Argument List

JJ	-	Calculation flag
		If JJ=1: calculate initialization parameters If JJ=2: calculate ionospheric properties
ZH	-	Altitude of interest (km)

ATMOUP Common

IDORN	-	Parameter for day or night. If COSCHI is the cosine of the zenith angle of the sun at point P, IDORN is 1 for daytime, i.e., IF(COSCHI.GE. 0.0), and is -1 for nighttime, i.e., IF(COSCHI.LT.0.0)
SNI(1)	-	N_2 concentration ($1/cm^3$)
SNI(2)	-	O_2 concentration ($1/cm^3$)
SNI(3)	-	O concentration ($1/cm^3$)
TT	-	Heavy-particle temperature (°K)

ALTODN Common

ALTKM(47)	-	The array of altitudes at which minor species are specified as data in SPCMIN

RATE Function Routine

Reaction rate coefficients for chemical reactions (This routine prepared by Knapp and Jordano [Vol. 11].)

DATA

HEBOTD	-	Altitude below which the daytime electron density decreases exponentially and above which the logarithm of the daytime electron density increases parabolically (km)
EBOTD	-	Daytime electron density at altitude HEBOTD ($1/cm^3$)

(cont'd)

Table 19. (Continued).

HF2MXD	-	Altitude at which the maximum daytime electron density occurs (km)
EF2MXD	-	Daytime electron density at altitude HF2MXD ($1/cm^3$)
EDDSCH	-	Scale height with which the daytime electron density decreases below altitude HEBOTD (km)
F2DSCH	-	Scale height with which the daytime electron density decreases above altitude HF2MXD
HEBOTN	-	Altitude below which the nighttime electron density decreases exponentially and above which the logarithm of the nighttime electron density increases sinusoidally (km)
EBOTN	-	Nighttime electron density at altitude HEBOTN ($1/cm^3$)
HF2MXN	-	Altitude at which the maximum nighttime electron density occurs (km)
EF2MXN	-	Nighttime electron density at altitude HF2MXN ($1/cm^3$)
EDNSCH	-	Scale height with which the nighttime electron density decreases below altitude HEBOTN (km)
F2NSCH	-	Scale height with which the nighttime electron density decreases above altitude HF2MXN.
TXT120	-	The difference between the electron temperature and the gas temperature at 120-km altitude in the ambient daytime ionosphere (°K)
TXT200	-	The difference between the electron temperature and the gas temperature at 200-km altitude in the ambient daytime ionosphere (°K)
TXT800	-	The difference between the electron temperature and the gas temperature at 800-km altitude in the ambient daytime ionosphere (°K)
DQDAY(18)	-	The effective total ion production rate at altitudes 0(5)85 km that reproduces the ambient daytime D-region ionosphere when used with the chemistry model (ion pairs/[cm^3 sec])

(cont'd)

Table 19. (Continued).

DQNIT(18)	-	The effective total ion production rate at altitudes 0(5)85 km that reproduces the ambient nighttime D-region ionosphere when used with the chemistry model (ion pairs/[cm^3 sec])
OUTPUT VARIABLES		
ATMOUP Common		
SNI(9)	-	Electron concentration for ZH $\geq$ 90 km (1/cm^3)
SNI(10)	-	Atomic oxygen ion concentration for ZH $\geq$ 90 km (1/cm^3)
SNI(11)	-	Molecular ion concentration for ZH $\geq$ 90 km (1/cm^3)
SNI(12)	-	Electron (and N_2 vibration) temperature (°K)
IONOUP Common		
EFE	-	See SNI(9) above.
EFOP	-	See SNI(10) above.
EFMOLP	-	See SNI(11) above.
TX	-	See SNI(12) above.
QDEF	-	The effective total ion production rate that reproduces the ambient ionosphere when used with the chemistry model

where

$[O^+]$ = positive atomic-ion density (cm^{-3})

$[M^+]$ = positive molecular-ion density (cm^{-3})

q_1 = atomic-ion production rate ($cm^{-3}\ sec^{-1}$)

q_2 = molecular-ion production rate ($cm^{-3}\ sec^{-1}$)

$\beta = k_1[N_2] + k_2[O_2]$

k_1 = ion-molecule interchange rate coefficient (cm^3/sec)

k_2 = ion-molecule charge-exchange coefficient (cm^3/sec)

α_r = effective two-body collisional-radiative recombination rate coefficient for atomic ions (cm^3/sec) [KJ-74b]

$= k_{11}(T_x) + k_{12}(T_x)[e] + 1.5 \times 10^{-7}[e]^{\frac{1}{2}} T_x^{-3}$

$k_{11}(T_x)$ = radiative recombination rate coefficient for the reaction $O^+ + e \rightarrow O + h\nu$

$k_{12}(T_x)$ = collisional-radiative recombination rate coefficient for the reaction $O^+ + e + e \rightarrow O + e$

α_d = dissociative recombination rate coefficient for the reaction $M^+ + e \rightarrow$ products (cm^3/sec).

By assuming charge conservation,

$$[e] = [O^+] + [M^+] \ , \tag{3}$$

one can write Eqs. (1) and (2) as

$$q_1 - \beta[O^+] - \alpha_r[O^+][e] = 0 \tag{4}$$

$$q_2 + \beta[O^+] - \alpha_d[M^+][e] = 0 \ . \tag{5}$$

Let

$$q_1 = f\,q \quad , \tag{6}$$

where

$$f = \frac{[O]}{[O] + 2[M]} \tag{7}$$

and

$$q = q_1 + q_2 \quad . \tag{8}$$

By adding Eqs. (4) and (5) and using Eq. (8), we have

$$q = \left\{\alpha_d[M^+] + \alpha_r[O^+]\right\}[e] \quad . \tag{9}$$

We have five equations [(3), (4), (5), (6), and (8)] and six variables; we can get analytic solutions for the five variables if we regard the electron density as given.

Equations (4) and (6) give

$$fq - \beta[O^+] - \alpha_r[O^+][e] = 0 \tag{10}$$

or

$$q = \left\{\beta + \alpha_r[e]\right\} f^{-1}[O^+] \quad . \tag{11}$$

Use Eqs. (9) and (11) to eliminate q:

$$\left\{\alpha_d[M^+] + \alpha_r[O^+]\right\}[e] = \left\{\beta + \alpha_r[e]\right\} f^{-1}[O^+] \quad . \tag{12}$$

Eliminate $[M^+]$ from Eq. (12) by using Eq. (3) to get

$$[O^+] = \frac{\alpha_d\, f\, [e]^2}{\beta + [e][\alpha_d f + \alpha_r(1 - f)]} \quad . \tag{13}$$

Eliminate $[O^+]$ from Eq. (11) by using Eq. (13) to get

$$\boxed{q = \frac{\alpha_d [e]^2 \left\{1 + \alpha_r [e] \beta^{-1}\right\}}{1 + [e] \beta^{-1} \left\{\alpha_d f + \alpha_r (1 - f)\right\}}} \quad . \tag{14}$$

Thus we have expressed q as a function of [e]. This equation differs from the corresponding equation in RANC IV [GE-70, Eq. (2-276)] by containing terms involving α_r.

The reader who likes Eq. (13) for $[O^+]$ can use it, of course, but we have used another expression for $[O^+]$,

$$\boxed{[O^+] = \frac{f\,q}{\beta + \alpha_r [e]}} \quad , \tag{15}$$

obtained by solving Eq. (11) for $[O^+]$, since q is known from Eq. (14).

From Eqs. (5), (8), (6), and (3) we get

$$\boxed{[M^+] = \frac{q(1 - f) + \beta [e]}{\beta + \alpha_d [e]}} \quad . \tag{16}$$

It may be shown that the sum of $[O^+]$ and $[M^+]$, as given by Eqs. (15) and (16), satisfies the requirement of charge conservation expressed by Eq. (3); this is not true for the corresponding RANC IV equations [GE-70, Eqs. (2-274) and (2-275)].

In Subroutine IONOSU we use Eqs. (14), (15), and (16) to compute q, $[O^+]$, and $[M^+]$ after prescribing analytic fits to nominal profiles

of E- and F-region electron density [Ri-73, Fig. 1] and electron temperature [Ev-73].

The prescribed electron-density profiles in the E- and F-region for noon and midnight conditions are shown in Fig. 13. The fit functions used to obtain these profiles are described in Table 20.

The prescribed electron temperature profile and the heavy-particle temperature profile in the E- and F-region for noon and midnight conditions are shown in Fig. 14. The fit function used to obtain the electron temperature profile is described in Table 21.

For approximately mean solar-flux conditions, SBAR $\equiv \overline{S} \approx 158 \times 10^{-22}$ W m^{-2} Hz^{-1}, profiles of q are shown for noon and midnight conditions in Fig. 15 and the corresponding values of O^+ and M^+ are shown in Fig. 13.

5.2 D-REGION IONOSPHERIC PROPERTIES

The D-region chemistry module requires the following quantity:

> q, the effective total ion production rate that adequately reproduces the ambient ionosphere when used with the chemistry model.

The modeling of q in the D region (and lower) is offered with reservations; it may need to be improved if experience shows that this topic is more important than it is presently assumed to be for radar.

For the D region, q is determined by specifying data points at 30- and 60-km altitude and by requiring the fit function to be continuous with the value of q derived from the E- and F-region model at 90-km altitude. The fit function is extrapolated below 30-km altitude for modeling convenience and not on a physical basis.

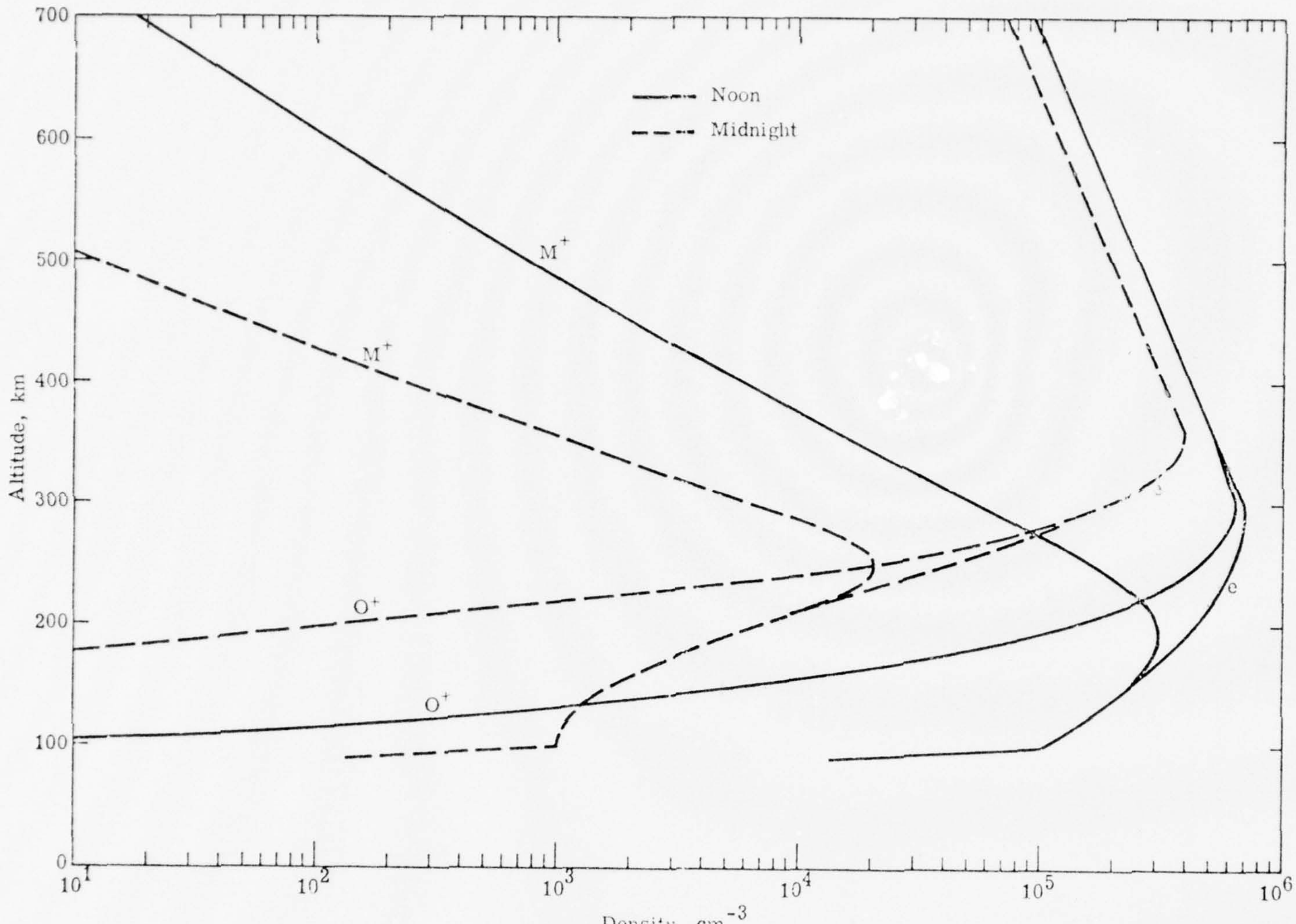

Fig. 13. E- and F-Region Ionospheric Species Densities. The electron density profiles are prescribed to be independent of the solar-flux conditions. The atomic-(O^+) and molecular-ion (NO^+) densities are IONOSU-computed steady-state values for approximately average solar-flux conditions ($\overline{S} \approx 158 \times 10^{-22}$ W m^{-2} Hz^{-1}).

Table 20. Fit Functions for E- and F-Region Electron Density Profiles.[a]

Altitude Range, km	Description
	Day
90-100	Exponential, determined by data-point value (EBOTD) at 100-km altitude (HEBOTD) and scale height EDDSCH
100-300	Parabola, determined by data-point values EBOTD and EF2MXD at altitudes HEBOTD and HF2MXD and vertical slope at altitude HF2MXD
> 300	Exponential, determined by data-point value (EF2MXD) at 300-km altitude (HF2MXD) and scale height F2DSCH
	Night
90-100	Exponential, determined by data-point value (EBOTN) at 100-km altitude (HEBOTN) and scale height EDNSCH
100-360	Sinusoid, determined by data-point values EBOTN and EF2MXN at altitudes HEBOTN and HF2MXN and vertical slope at the same altitudes
> 360	Exponential, determined by data-point value (EF2MXN) at 360-km altitude (HF2MXN) and scale height F2NSCH

[a]Based on Fig. 1 in Ri-73.

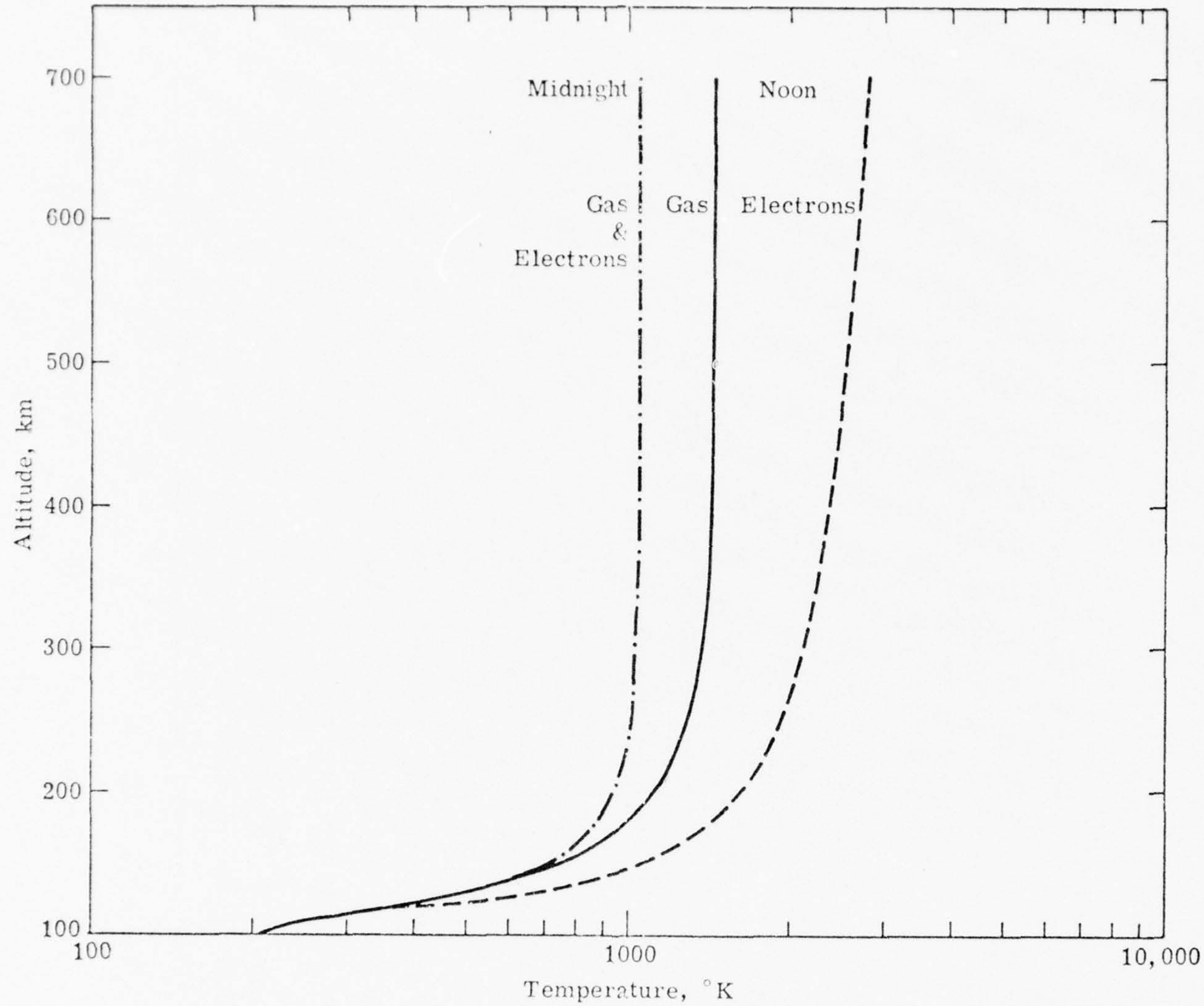

Fig. 14. E- and F-Region Ionospheric Temperatures. The difference between the electron and gas temperatures is prescribed to be independent of the solar-flux conditions. The absolute values shown are IONOSU-computed values for approximately average solar-flux conditions ($\bar{S} \approx 158 \times 10^{-22}$ W m^{-2} Hz^{-1}).

Table 21. Fit Function for Electron Temperature Profile.

Altitude Range, km	Description
Day	
< 120	Same as heavy-particle temperature
≥ 120	The difference between the electron temperature (T_X) and the gas temperature (T) is prescribed to be zero at 120-km altitude and 500° K at 200-km altitude. The parabola $$T_X - T = 500\,[(ZH - 120)/80]^{\frac{1}{2}}$$ is then used.
Night	
≥ 0	Same as heavy-particle temperature

The data adopted are based on the calculations of Webber [We-62] for the ion-production rate due to galactic cosmic rays. Webber [We-62, Fig. 2] presents results in the altitude range from 30 to 90 km for two geomagnetic latitudes (50° and 70°) and for sunspot-minimum and sunspot-maximum conditions. For the geomagnetic latitude of 50°, Webber [We-62] finds $q_{max} = 0.04$ and $q_{min} = 0.08$ at 60-km altitude and $q_{max} = 2.1$ and $q_{min} = 4.5$ at 30-km altitude. We adopt solar-cycle mean values of 0.06 and 3.3 at 60- and 30-km altitude, respectively. The interested reader may also wish to consult Ra-72 (Fig. 2.3) and Po-73a (Figs. 2 and 3).

The profiles of q in the D and adjacent regions for noon and midnight conditions are shown in Fig. 16. The fit functions used to obtain these profiles are described in Table 22.

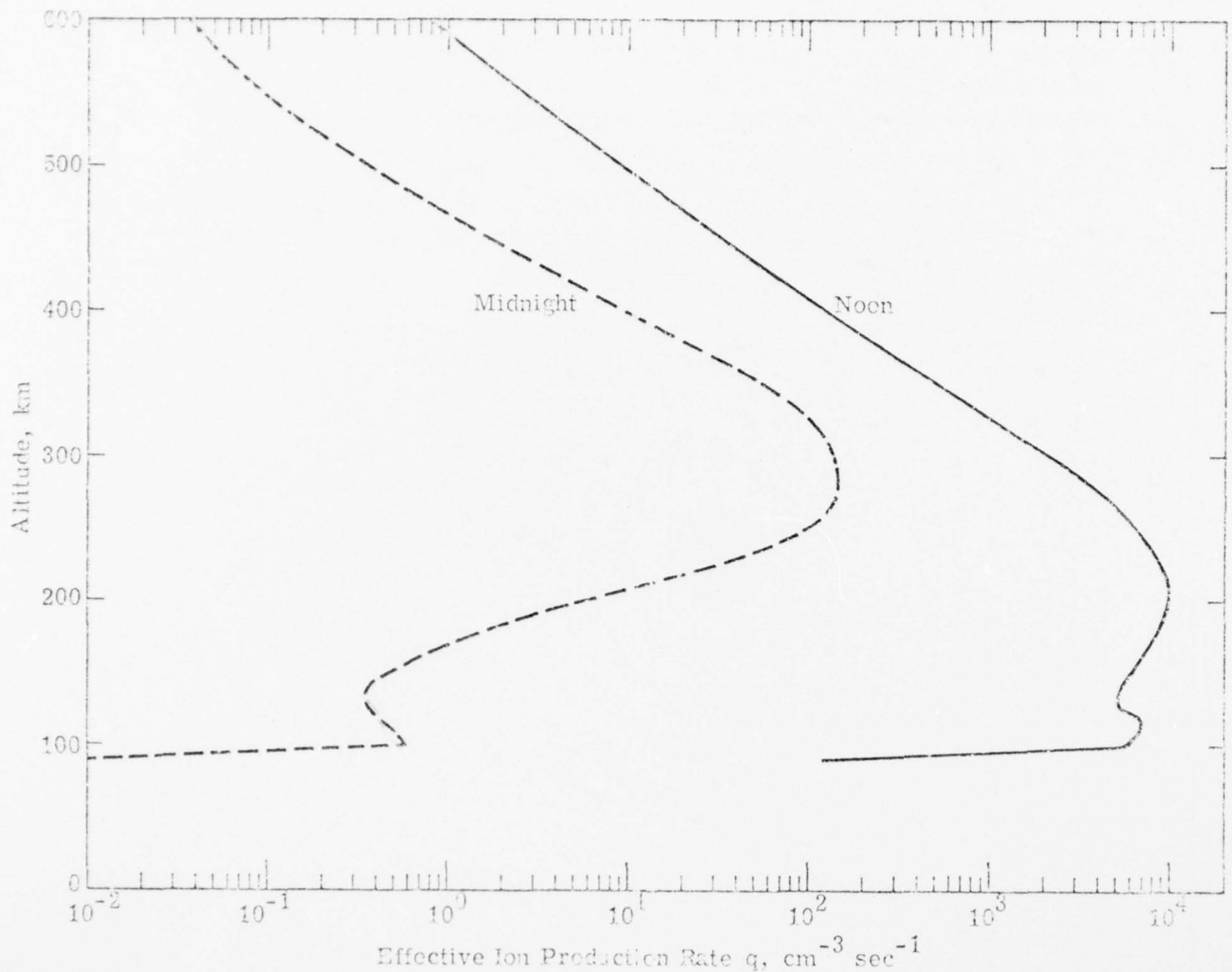

Fig. 15. E- and F-Region Effective Ion Production Rates. The values shown are IONOSU-computed steady-state values for the prescribed electron density profiles in Fig. 12 and for approximately average solar-flux conditions ($\bar{S} \approx 158 \times 10^{-22}$ W m^{-2} Hz^{-1}).

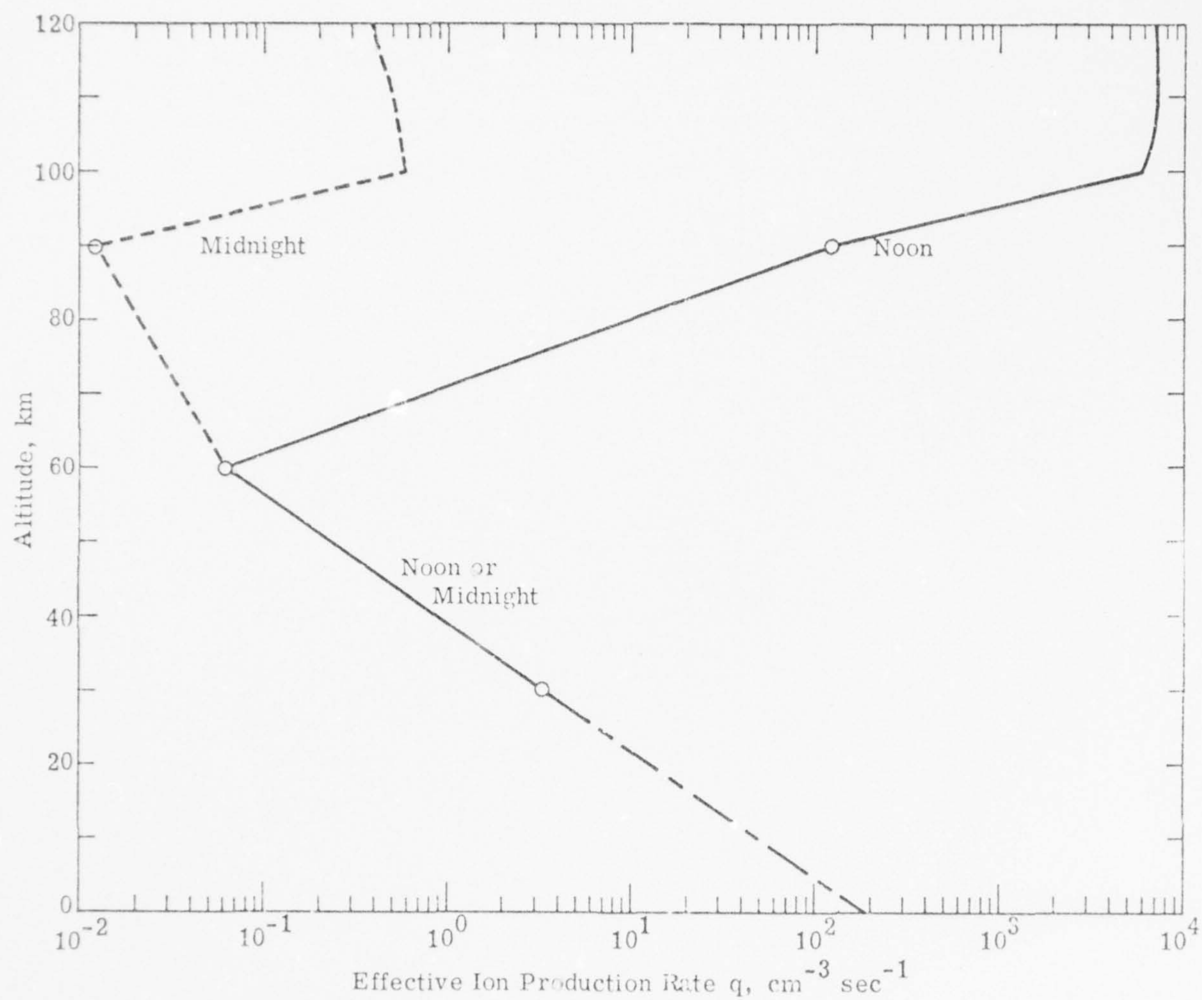

Fig. 16. D-Region Effective Ion Production Rates. The values shown are IONOSU-computed fit functions required to pass through adopted data-base values at 30- and 60-km altitude and to join the IONOSU E- and F-region values at 90-km altitude. The extrapolation below 30-km altitude is purely for modeling convenience.

Table 22. Fit Functions for Effective Ion Production Rate in D and Lower Regions.

Altitude Range, km	Description
	<u>Day</u>
0-60	Exponential, determined by data-point values at 30- and 60-km altitude
60-90	Exponential, determined by data-point values at 60-km altitude and daytime value of q from E- and F-region model at 90-km altitude
	<u>Night</u>
0-60	Same as daytime
60-90	Exponential, determined by data-point value at 60-km altitude and nighttime value of q from E- and F-region model at 90-km altitude

6. DRIVER, LISTING OF COMPUTER PROGRAM, AND SAMPLE PROBLEM RESULTS

A short driver routine is provided to exercise the ATMOSU, SPCMIN, IONOSU, and associated routines. The required input consists of the year, month, day, zone time, geographic colatitude and longitude of the point of interest, a set of test altitudes, and the number of such altitudes. Input quantities are more specifically described below in Table 23. The driver, after reading and writing the input, first initializes the ATMOSU routine by the call ATMOSU(1, 120.). The driver next loops over the test-altitude array, exercises the ATMOSU, SPCMIN, and IONOSU routines for each altitude, and prints out the resultant atmospheric and ionospheric property values.

A listing of the driver, ATMOSU, SPCMIN, IONOSU, their associated subroutines, and outputs from two sample problems are provided.

The quantities in the output block at each altitude are labeled in the headings. The last four entries (E, O^+, M^+, and N^+) in row-two of the output block at each altitude ($\geq$ 90 km) are computed by Subroutine CHEMQ and are included for comparison with the quantities E, O^+, and M^+ in row-one computed by IONOSU. Subroutine CHEMQ, prepared by Knapp and Jordano [see Vol. II] for use with the NRL Simple-Chemistry module, computes steady-state ionization for the E- and F-region.

Table 23. Input Quantities to DRIVER

a.	NALTS (FORMAT-I5)	-	Number of test altitude values
b.	ALTA(I)	-	Test altitude values (km), eight values per card; NALTS values in total
	(FORMAT-8F10.2)		
c.	IYRS	-	Number of the year in the 1900's at east longitude GLO (e.g., 1974 becomes 74)
	IMONS	-	Number of the month at east longitude GLO (e.g., February becomes 2)
	IDAYS	-	Day of the month at east longitude GLO.
	ZT	-	Zone time for the 15-degree longitude interval containing east longitude GLO.
	GCO	-	Geographic colatitude of grid origin or whatever reference point is desired (degrees)
	GLO	-	Geographic east longitude of grid origin or whatever reference point is desired (degrees)
	(FORMAT 3I5. 3E10.4)		

```
 53         WRITE(6,2002)(I,ALTS(I),I=1,NALTS)
      2002 FORMAT (5X,6(I8,2X,F10,2))
 71         WRITE(6,2004)  IYRS,IMONS,IDAYS,ZT,GCO,GLO
      2004 FORMAT (//,8H  IYRS =I5,10H   IMONS =I5,10H   IDAYS =I5/
          * 8H    ZT =F12.4,14H HRS     GCO =E12.4,14H DEG     GLO =F12.4,
          * 4H DEG)
      C         CONVERT GCO AND GLO FROM DEGREES TO RADIANS.
112         GCO = GCO*RADDEG
113         GLO = GLO*RADDEG
      C         IDENTIFY THE GRID ORIGIN AS THE POINT P.
114         PLAT = PID2-GCO
116         PLON = GLO
      C
      C  *  *  INITIALIZE THE ATMOSU ROUTINE
      C
117         WRITE(6,8020)
      8020 FORMAT(//20H INITIALIZATION CALL,//)
      C
123         CALL ATMOSU(1,120.)
      C
125         WRITE(6,2006)  IYRS,IMONS,IDAYS,ZT,GCO,GLO
      2006 FORMAT (//,8H  IYRS =I5,10H   IMONS =I5,10H   IDAYS =I5/
          * 8H    ZT =E12.4,14H HRS     GCO =E12.4,14H RAD     GLO =F12.4,
          * 4H RAD)
145         WRITE(6,2005)  IDORN,UT,GAT,PLAT,PLON
      2005 FORMAT (//,8H IDORN =I5,10H      UT =E12.4,10H     GAT =E12.4,10H
          *   PLAT =E12.4,10H    PLON =E12.4)
163         WRITE(6,2003)HL,SBAR
      2003 FORMAT(//,5H HL =,F10.3,5X,7H SBAR =,F10.3)
      C
      C  *  *  LOOP OVER TEST ALTITUDES
      C
173         WRITE(6,8002)
      8002 FORMAT (1H0,129H     ALT        N2            O2            O
          * AR           HE           CO2          E            O+           M+
          *        QDEF    /10X,9(5X,4H1/CC,3X),2X,10H1/(CC SEC))
177         WRITE(6,8003)
      8003 FORMAT (1H0,9X,120H        N            NO           NO2         O2(SDG)
          *         O3           H2O          E            O+           M+
          * N+     /10X,10(5X,4H1/CC,3X))
203         WRITE(6,8004)
      8004 FORMAT (1H0,9X,72H    PRESSURE     FEHSEQ       DENSITY      DEN SC HT
          *        TEMP        E TEMP  /10X,72H DYNES/CM**2              GRAMS/C
          *C          KM          DEG K        DEG K  )
207         DO 50 I=1,NALTS
211         ZH = ALTS(I)
213         CALL ATMOSU(2,ZH)
215         CALL SPCMIN(2,ZH)
217         CALL IONOSU(2,ZH)
221         ENEO = 0.0
222         UPQ  = 0.0
222         ENPO = 0.0
223         IF( ZH.LT.90. )  GO TO 45
226         CN2 = SNI(1)
227         CO2 = SNI(2)
230         CO = SNI(3)
232         CNO = SNI(8)
233         CN4S = SNI(7)
235         CN2D = 1.0
236         CNP = 0.0
237         COP = 0.0
240         CENE = 0.0
240         TV = TX
242         TE = TX
```

```
242          TG = TT
244          CALL CHEMQ(QDEF,ENPQ,OPQ,ENFQ)
247       45 EMPQ = ENFQ-OPQ-ENPQ
252          WRITE(6,8005)  7H,(SNI(J),J=1,6),(SNI(J),J=9,11),QDEF,SNI(7),
            *               SNI(8),SNI(15),SNI(13),SNI(14),SNI(16),ENEQ,OPQ,
            *               EMPQ,ENPQ,PP,FEHSEQ,RHO,HRHO,TT,SNI(12)
        8005 FORMAT (1X,F9.2,10E12.3/(10X,10E12.3))
335       50 CONTINUE
       C
340          WRITE(6,9050)
        9050 FORMAT(//,20H END OF TEST PROBLEM)
343          GO TO 1010
344          END
```

```
      SUBROUTINE ATMOSU(JJ,ZH)                                          DRIVER.135
C                                                                       DRIVER.136
C        ATMOSU COMPUTES THE PROPERTIES OF THE UNDISTURBED ATMOSPHERE,  DRIVER.137
C        GIVEN THE ALTITUDE ZH, AFTER ASSOCIATED SUBROUTINES COMPUTE    DRIVER.138
C        THE LOCAL APPARENT TIME HL, SOLAR FLUX SBAR, AND DAY-OR-NIGHT DRIVER.139
C        PARAMETER IDURN.                                               DRIVER.140
C        ATMOSU IS REVISION 09 (06/02/75) OF ATMOS DEVELOPED BY R. W.   DRIVER.141
C        LOWEN (SEE, AN AMBIENT ATMOSPHERE MODEL FOR ROSCOE, P. 187,    DRIVER.142
C        VOL. 5 OF PROC. DNA 1973 ATMOSPHERIC EFFECTS SYMPOSIUM, DNA    DRIVER.143
C        3131P-5, 5 JUNE 1973.)                                         DRIVER.144
C        REVISION 02 (06/07/74) PROVIDES                                DRIVER.145
C           1. IN HIGH-ALTITUDE MODEL, FOR USE OF GAF(120.) INSTEAD OF  DRIVER.146
C              GAF(0.) = GZ IN COMPUTING GAM AND Z7.                    DRIVER.147
C           2. DENSITY SCALE HEIGHT FOR BOTH LOW- AND HIGH-ALTITUDE     DRIVER.148
C              MODELS, WITH AN AD HOC PARABOLIC TRANSITION FROM 110- TODRIVER.149
C              120-KM ALTITUDE TO PROVIDE A CONTINUOUS DENSITY SCALE    DRIVER.150
C              HEIGHT ACROSS THE BOUNDARY BETWEEN THE TWO MODELS.       DRIVER.151
C           3. ALTERED FORMULA FOR O DENSITY ON FIRST CALL AND AT LOW   DRIVER.152
C              ALTITUDE SO AS TO USE SF-FUNCTION DIRECTLY.              DRIVER.153
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C              (OBTAINED FROM THE MINOR SPECIES SUBROUTINE SPCMIN)      DRIVER.157
C              FOR ALTITUDES BELOW 120 KM.                              DRIVER.158
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C              TRANSITION REGION.                                       DRIVER.161
C           7. PROCEDURE FOR LETTING SOLAR FLUX SBAR, AN INPUT TO       DRIVER.162
C              ATMOSU, BE DETERMINED BY THE AUXILIARY ROUTINE SOLCYC.   DRIVER.163
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C              AN INPUT TO ATMOSU, BE DETERMINED BY THE AUXILIARY       DRIVER.165
C              SUBROUTINE SOLORB.                                       DRIVER.166
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C              BE DETERMINED BY THE AUXILIARY SUBROUTINE SOLZEN.        DRIVER.168
C        REVISION 04 (12/08/74) PROVIDES                                DRIVER.169
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C              WAS LAST CALLED.                                         DRIVER.175
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      COMMON/ATMOUP/  HL,SBAR,IDORN,PP,RHO,TT,SNI(16),HRHO,FEHSEQ       DRIVER.222
      COMMON/TIME/  IYRS,IMONS,IDAYS,ZT,PLAT,PLON,UT,GAT                DRIVER.223
      COMMON/ALTODN/  NALTOD,ALTKM(47),ODAY(27),ONITE(18),SIZ2N,CO2(25) DRIVER.224
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C        VARIABLES IN ATMOUP                                            DRIVER.226
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C             SBAR = AVER. 10.7-CM SOLAR FLUX, 1.E-22 W/(M**2 HZ)       DRIVER.228
C            IDORN = INDEX FOR DAY OR NIGHT, FOR O BELOW 120 KM, USE    DRIVER.229
C                    DAYTIME PROFILE IF(IDORN.GE.0) AND NIGHTTIME       DRIVER.230
C                    PROFILE IF(IDORN.LT.0)                             DRIVER.231
C               PP = PRESSURE, DYNES/CM**2                              DRIVER.232
C              RHO = DENSITY, G/CM**3                                   DRIVER.233
C               TT = TEMPERATURE, DEGREES KELVIN                        DRIVER.234
C           SNI(1) = N2,   1/CM**3   (FROM ATMOSU)                      DRIVER.235
C           SNI(2) = O2,   1/CM**3   (FROM ATMOSU)                      DRIVER.236
C           SNI(3) = O,    1/CM**3   (FROM ATMOSU)                      DRIVER.237
C           SNI(4) = AR,   1/CM**3   (FROM ATMOSU)                      DRIVER.238
C           SNI(5) = HE,   1/CM**3   (FROM ATMOSU)                      DRIVER.239
C           SNI(6) = CO2,  1/CM**3   (FROM ATMOSU)                      DRIVER.240
C           SNI(7) = N,    1/CM**3   (FROM SPCMIN)                      DRIVER.241
C           SNI(8) = NO,   1/CM**3   (FROM SPCMIN)                      DRIVER.242
C           SNI(9) = E,    1/CM**3   (FROM IONOSU)                      DRIVER.243
C          SNI(10) = O+,   1/CM**3   (FROM IONOSU)                      DRIVER.244
C          SNI(11) = M+,   1/CM**3   (FROM IONOSU)                      DRIVER.245
C          SNI(12) = TX,   DEG K     (FROM IONOSU)                      DRIVER.246
```

```
C         SNI(13) = O2(1DG), 1/CM**3   (FROM SPCMIN)
C         SNI(14) = O3,      1/CM**3   (FROM SPCMIN)
C         SNI(15) = NO2,     1/CM**3   (FROM SPCMIN)
C         SNI(16) = H2O,     1/CM**3   (FROM SPCMIN)
C            HRHO = DENSITY SCALE HEIGHT, KM
C          FEHSEQ = FRACTIONAL ERROR IN HYDROSTATIC EQUILIBRIUM.
C
C
      COMMON/ZHCHEX/  ZHFLAG
C
      DIMENSION  A(6),B(5),C(6),S(5),BB(3),AA(12),DD(13)
      DIMENSION  SNIZ(6), SMI(6), ALP(6)
      DIMENSION  D(20,21),X(6),XC(7),ZIM2ON(5),ZION(5),ONZI(5)
      DIMENSION  ZIM1C(5),ZIC02(5),CO2ZI(5)
      DIMENSION  FDAY(27)
C
C        DEFINITIONS OF DATA QUANTITIES
C             BIGMS = SEA-LEVEL MEAN MOLECULAR WEIGHT, G/MOLE
C                PZ = SEA-LEVEL PRESSURE, DYNES/CM**2
C              BIGA = AVOGADRO NUMBER, PARTICLES/MOLE
C                RR = UNIVERSAL GAS CONSTANT, ERG/(MOLE DEG-K)
C                     (SET IN SUBROUTINE, RR=SK*BIGA)
C
      DATA  BIGMS,PZ,BIGA / 28.96,1.01325E+06,6.022169E+23 /
C
C                SK = BOLTZMANN CONSTANT, ERG/(DEG-K)
C              NDEG - DEGREE OF POLYNOMIAL TO BE FITTED FOR THE
C                     DAYTIME O PROFILE
C
C        CAUTION ----  NDEG MUST NOT EXCEED 12 WITHOUT MAKING
C                      APPROPRIATE CHANGES IN PROGRAM.
      DATA  PI,SK / 3.141592653590,1.380622E-16 / , NDEG / 12 /
C
C                GZ = SEA-LEVEL GRAVITATIONAL ACCELERATION, CM/SEC**2
C                RE = RADIUS OF SPHERICAL EARTH, KM
C
      DATA  GZ, RE / 980.621, 6.36765E+03 /
C
C                IS = TOTAL NUMBER OF SPECIES
C            SMI(I) = MASS OF N2, O2, O, AR, HE, AND CO2,  GRAMS
C
      DATA  IS, (SMI(I),I=1,6) /  6, 4.6517E-23, 5.3135E-23, 2.6567E-23,
     *                              6.6335E-23, 6.6464E-24, 7.3080E-23/
C
C           ALP(I) = THERMAL DIFFUSION COEFFICIENT
C
      DATA  (ALP(I),I=1,6) /  4*0.0, -0.40, 0.0 /
C
C
C        COEFFICIENTS G-SUB-K FOR G/TM
C
      DATA  (AA(I),I=1,12) /  3.39543882E+00,  2.63451493E-02,
     *                        2.34156416E-02, -2.74474436E-03,
     *      1.43387285E-04, -4.34694163E-06,  8.17220927E-08,
     *     -9.59552213E-10,  6.82335587E-12, -2.68405784E-14,
     *      4.47990722E-17,  0.0 /
```

```
      CCC
      C * * * ARITHMETIC STATEMENT FUNCTIONS TO CALCULATE
      C * * * G/TM, INTEGRAL OF G/TM, AND G.
      CCC
            GDTMAF( AQ ) = (((((((((( AA(12)*AQ + AA(11))*AQ + AA(10))*AQ
           *             + AA(9))*AQ + AA(8))*AQ + AA(7))*AQ + AA(6))*AQ
           *             + AA(5))*AQ + AA(4))*AQ + AA(3))*AQ + AA(2))*AQ + AA(1)
      C
            GTMIAF( AQ ) = (((((((((((AA(12)/12.*AQ + AA(11)/11.)*AQ
           *             + AA(10)/10.)*AQ + AA(9)/9.)*AQ + AA(8)/8.)*AQ
           *             + AA(7)/7.)*AQ + AA(6)/6.)*AQ + AA(5)/5.)*AQ
           *             + AA(4)/4.)*AQ + AA(3)/3.)*AQ + AA(2)/2.)*AQ + AA(1))*AQ
      C
            GAF( BQ ) = GZ/(1.0+BQ/RE)**2
      CCC
      C * * * ARITHMETIC STATEMENT FUNCTION USED TO CALCULATE M/MSTAR DAY.
      CCC
            SFDAF( BQ ) = EXP( ((((((((((((DD(13)*BQ + DD(12))*BQ + DD(11))*BQ
           *                + DD(10))*BQ + DD(9))*BQ + DD(8))*BQ + DD(7))*BQ
           *                + DD(6))*BQ + DD(5))*BQ + DD(4))*BQ + DD(3))*BQ
           *                + DD(2))*BQ + DD(1) )
      CCC
      C * * * ARITHMETIC STATEMENT FUNCTION USED TO CALCULATE DENSITY SCALE
      C * * * HEIGHT (KM).
      CCC
            GKKZAF( AQ ) = ((((((((( AA(12)*11.*AQ + AA(11)*10.)*AQ
           *             + AA(10)*9.)*AQ + AA(9)*8.)*AQ + AA(8)*7.)*AQ
           *             + AA( 7)*6.)*AQ + AA(6)*5.)*AQ + AA(5)*4.)*AQ
           *             + AA( 4)*3.)*AQ + AA(3)*2.)*AQ + AA(2)
      CCC
      C          STATEMENTS 100 TO 200-1 ARE DONE JUST ONCE, ON A CALL TO
      C          ATMOSU(1,120), TO SET UP NEEDED PARAMETERS AND TO EVALUATE
      C          SOLAR-FLUX-DEPENDENT FOURIER COEFFICIENTS USED IN COMPUTING
      C          THE TIME-DEPENDENT VALUES OF TAU, THE VARIABLE CONTROLLING THE
      C          TEMPERATURE GRADIENT AT THE LOWER BOUNDARY, TIF, THE
      C          EXOSPHERIC TEMPERATURE (SEE J. S. NISBET, RADIO SCIENCE VOL.
      C          6, P. 437 (1971)), AND THE COEFFICIENTS IN THE PARABOLIC
      C          TRANSITION FUNCTION FOR THE DENSITY SCALE-HEIGHT BETWEEN
      C          THE LOW- AND HIGH-ALTITUDE MODELS.
      C          SUBSEQUENT CALLS, TO ATMOSU(2,ZH),   GO TO STATEMENT 200
      C          WHEREAFTER A LOW-ALTITUDE MODEL IS USED FOR ALTITUDES ZH
      C          LESS THAN 120 KM AND A HIGH-ALTITUDE MODEL IS USED OTHERWISE.
            GO TO (100,200), JJ
      CCC
      CCC        INITIALIZATION
      CCC
172     100 RR = SK*BIGA
174         CC1 = 1.0E+05*BIGMS/RR
      C          COMPUTE GRAV. ACCEL. G, G DIVIDED BY MOL. SCALE TEMP. TM, AND
      C          INTEGRAL OF G/TM AT 120 KM.
176         GG = GAF( ZH )
177         GDTM = GDTMAF( ZH )
201         GDTMI = GTMIAF( ZH )
      C          COMPUTE PRESSURE, DENSITY, AND TEMPERATURE AT 120 KM
      C          ACCORDING TO THE LOW-ALTITUDE MODEL.  THESE VALUES PROVIDE
      C          THE BOUNDARY CONDITIONS AT 120 KM FOR THE HIGH-ALTITUDE MODEL.
```

```
203         PP = PZ*EXP(-CC1*GDTMT + 9.4144E-08*ZH**2.833)
215         RHO = BIGMS*GDTM/RR*PP/GG
      C          NOW CALL THE 6 AUXILIARY ROUTINES.
221         CALL ZTTOUT
222         CALL JULIAN(IYRS,IMONS,IDAYS,YREJ,VEQJ,DAYJ)
226         CALL SOLCYC(DAYJ)
230         CALL SOLORB(YREJ,VEQJ,DAYJ,SOLLAT,SOLLON)
234         CALL SOLZEN(SOLLAT,SOLLON)
236         CALL SPCMIN(1,ZH)
      C          COMPUTE M/MSTAR (DEPENDS ON DAY OR NIGHT PROFILE OF O, IN
      C          PRINCIPLE, BUT WE COMPUTE IT ONLY FOR DAY) AFTER COMPUTING
      C          COEFFICIENTS DD(I).
241         BA2RR = 2.*BIGA/RR
244         DO 104 N=1,NALTOD
247         WZZ = ALTKM(N)
250         WGG = GAF( WZZ )
252         WGDTM = GDTMAF( WZZ )
254         WPP = PZ*EXP(-CC1*GTMIAF( WZZ ) + 9.4144E-08*WZZ**2.833)
271         BMARHO = WGG/(BA2RR*WPP*WGDTM)
273         FDAY(N)  = BMARHO*ODAY(N)
300     104 CONTINUE
303         DO 106 I=1,13
307         DD(I) = 0.0
310     106 CONTINUE
311         CALL FITTER(NALTOD,ALTKM,FDAY,NDEG, 1 , 2 , DD)
      C          USING DAY O PROFILE
317         SF = SFDAF( ZH )
323         BMBMS = 1.0/( 1. + SF )
325         TZ    = BMBMS*GG/GDTM
      C          COMPUTE THE SPECIES NUMBER DENSITIES AT 120 KM.
      C          COMPUTE TOTAL NUMBER DENSITY,N(1/CM**3)
330         SN = BIGA/BIGMS*RHO/BMBMS
      C          COMPUTE TOTAL NUMBER DENSITY IF NO DISSOCIATION,NSTAR(1/CM**3)
333         SNS = BIGA*RHO/BIGMS
      C          COMPUTE DENSITIES (1/CM**3) OF N2, O2, O, AR, HE, AND CO2.
334         SNIZ(1) = 0.78*SNS
335         SNIZ(2) = 1.211*SNS - SN
340         SNIZ(3) = 2.*SNS*SF
342         SNIZ(4) = 0.009*SNS
343         SNIZ(5) = 4.625E-05*SNS
345         SNIZ(6) = CO2(25)
      C
346         RE120 = RE+120.
350         GGSK = GG/SK
352         CC = PI*HL/12.
355         FF = SBAR
      C          COMPUTE FOURIER COEFFICIENTS USED FOR TAU AT 120 KM.
357         A(1) = +2.210156E-02 - 1.970030E-05 * FF
361         A(2) = +6.712358E-03 - 1.181107E-05 * FF
364         A(3) = +2.748180E-04 + 3.390522E-07 * FF
367         A(4) = -5.663477E-04 + 8.669016E-07 * FF
371         A(5) = -4.652258E-05 + 2.322930E-07 * FF
374         A(6) = +8.984354E-05 - 1.128157E-07 * FF
376         B(1) = -3.407398E-03 + 1.900959E-05 * FF
401         B(2) = -5.428597E-04 + 4.101313E-06 * FF
403         B(3) = -2.518983E-04 - 5.341112E-07 * FF
```

```
406          B(4) = -1.380845E-04 + 2.075324E-07 * FF
410          B(5) = +1.358994E-04 + 3.931811E-07 * FF
       C          COMPUTE FOURIER COEFFICIENTS USED FOR TIF.
413          C(1) = +5.443538E+02 + 4.328897E+00 * FF
415          C(2) = -1.179819E+02 - 6.495360E-01 * FF
420          C(3) = +3.115091E+01 - 4.766818E-02 * FF
422          C(4) = +4.069323E+00 + 4.154682E-02 * FF
425          C(5) = -6.389061E+00 + 1.415760E-02 * FF
427          C(6) = +1.045482E+00 - 1.995652E-02 * FF
432          S(1) = -1.138663E+01 - 7.298749E-01 * FF
434          S(2) = +1.359668E+01 + 2.815729E-03 * FF
437          S(3) = +9.859158E-01 + 8.138881E-02 * FF
441          S(4) = +7.061132E-01 - 1.151708E-02 * FF
444          S(5) = -2.925315E-01 - 4.625236E-02 * FF
       C          COMPUTE TAU (1/KM) AND TIF (DEGREES KELVIN)
446          TAU = A(1)
450          TIF = C(1)
452          DO 110 I=1,5
453          FI = I
454          SFI = SIN(CC*FI)
457          CFI = COS(CC*FI)
463          TAU = TAU + CFI*A(I+1) + SFI*B(I)
472      110 TIF = TIF + CFI*C(I+1) + SFI*S(I)
       C
       C          TO PROVIDE A CONTINUOUS DENSITY SCALE HEIGHT ACROSS THE
       C          BOUNDARY BETWEEN THE LOW- AND HIGH-ALTITUDE MODELS, WE USE A
       C          PARABOLIC TRANSITION FUNCTION,
       C              HRHO = FHR120 * ZHM110**2 + SB * ZHM110 + HRO110
       C          WHERE
       C            HRO110 = DENSITY SCALE HEIGHT AT 110 KM
       C            ZHM110 = ZH-110.
       C             SB    = APPROXIMATE DERIVATIVE OF DENSITY SCALE HEIGHT
       C                     AT 110-KM ALTITUDE
       C                   = HR1105-HR1095
       C            HR1105 = DENSITY SCALE HEIGHT AT 110.5 KM.
       C            HR1095 = DENSITY SCALE HEIGHT AT 109.5 KM.
       C            FHR120 = (HRO120 - 10.*SB - HRO110)/(120.-110.)**2
       C          IN THIS INITIALIZATION CALL WE NEED TO COMPUTE THE DENSITY
       C          SCALE HEIGHT AT 120 KM, HRO120, ACCORDING TO THE HIGH-ALTITUDE
       C          MODEL, WHICH DEPENDS ON HL AND SBAR, AND ALSO THE DENSITY
       C          SCALE HEIGHTS ACCORDING TO THE LOW-ALTITUDE MODEL AT 110 KM,
       C          110.5 KM, AND 109.5 KM.
       C          COMPUTE SMALL A.
500          SA = (TIF - TZ)/TIF
       C          COMPUTE COEFFICIENT OF M-SUB-I IN GAMMA-SUB-I
502          GAMI = 1.0E+05*GGSK/(TIF*TAU)
505          RHO = 0.0
506          DRODZN = 0.0
507          DO 120 I=1,IS
517          SNZSMI = SNIZ(I)*SMI(I)
520          GAM = GAMI*SMI(I)
521          ALGAM1 = ALP(I) + GAM + 1.0
523          RHO = RHO + SNZSMI
525          DRODZN = DRODZN + SNZSMI*(GAM + ALGAM1*SA/(1.-SA))
531      120 CONTINUE
532          HRO120 = RHO/DRODZN/TAU
```

```
      C          COMPUTE DENSITY SCALE HEIGHT AT 110 KM.                    DRIVER
534         GDTM = GDTMAF( 110. )                                            DRIVER
537         HR0110 = 1.0/(CC1*GDTM - 2.66709952E-07*110.0**1.833            DRIVER
           *         - 2.0/(RE+110.0) - GKKZAF( 110.0 )/GDTM)               DRIVER
      C          COMPUTE DENSITY SCALE HEIGHT AT 110.5 KM.                  DRIVER
556         GDTM = GDTMAF( 110.5 )                                           DRIVER
557         HR1105 = 1.0/(CC1*GDTM - 2.66709952E-07*110.5**1.833            DRIVER
           *         - 2.0/(RE+110.5) - GKKZAF( 110.5 )/GDTM)               DRIVER
      C          COMPUTE DENSITY SCALE HEIGHT AT 109.5 KM.                  DRIVER
576         GDTM = GDTMAF( 109.5 )                                           DRIVER
577         HR1095 = 1.0/(CC1*GDTM - 2.66709952E-07*109.5**1.833            DRIVER
           *         - 2.0/(RE+109.5) - GKKZAF( 109.5 )/GDTM)               DRIVER
616         SH = HR1105-HR1095                                               DRIVER
620         FHR120 = 0.01*(HR0120 - 10.*SH - HR0110)                         DRIVER
624         WRITE(6,8001)TIF,TAU                                             DRIVER
       8001 FORMAT(//,7H TIF = ,E13.6,7H TAU = ,E13.6,//)                    DRIVER
      C                                                                      DRIVER
      C          AT NIGHTTIME, O DIFFERS FROM DAYTIME O ONLY BELOW ALTITUDE  DRIVER
      C          ZION(5) = 90 KM.  IF( ZH.LT.ZION(1)), WHERE ZION(1) = 60 KM, DRIVER
      C          SNI(3) = ONZI(1) = ONITE(13) = 1.1  .                       DRIVER
      C          IF(ZH.GE.ZION(1) .AND. ZH.LT.ZION(2)), WHERE ZION(2) = 75 KM, DRIVER
      C          SNI(3) = ONZI(2)*EXP(ZM2ON*ONSCHI)  WHERE                   DRIVER
      C               ONZI(2) = ONITE(16) = 4.90E+08                         DRIVER
      C                 ZM2ON = ZH-ZION(2)                                   DRIVER
      C                ONSCHI = ALOG(ONZI(2)/ONZI(1))/(ZION(2)-ZION(1))      DRIVER
      C          IF(ZH.GT.ZION(2) .AND. ZH.LT.ZION(5))  WHERE ZION(5) = 90 KM, DRIVER
      C          SNI(3) = 10.**(((((X(1)*ZM2ON + X(2))*ZM2ON + X(3))*ZM2ON   DRIVER
      C                         + X(4))*ZM2ON + X(5))*ZM2ON + X(6))          DRIVER
      C          WHERE THE CONSTANTS X(I),I=1,6 ARE DETERMINED SO THAT THE   DRIVER
      C          SLOPE OF ALOG10(SNI(3)) AT ZION(2) = 75 KM, DLO72Z, AND AT  DRIVER
      C          ZION(5) = 90 KM, DLO75Z, IS CONTINUOUS AND ALOG10(SNI(3))   DRIVER
      C          EQUALS THE NIGHTTIME VALUES FOR O AT ZION(2) = 75 ,         DRIVER
      C          ZION(3) = 80 , AND ZION(4) = 85 KM AND EQUALS THE DAYTIME   DRIVER
      C          VALUE FOR O AT ZION(5) = 90 KM, ALOG10(ODAY75).             DRIVER
      C          THE NIGHTTIME O CONSTANTS ARE NOW SET.                      DRIVER
636         ZION(1) = ALTKM(13)                                              DRIVER
636         ONZI(1) = ONITE(13)                                              DRIVER
640         DO 130 I=2,5                                                     DRIVER
646         ZION(I) = ALTKM(I+14)                                            DRIVER
647         ONZI(I) = ONITE(I+14)                                            DRIVER
650     130 CONTINUE                                                         DRIVER
651         ZH2 = ZION(5)                                                    DRIVER
      C          TO RESET ONZI(5) TO ITS PROPER VALUE WE NEED TO FIRST       DRIVER
      C          CALCULATE ODAY75...                                         DRIVER
      C                                                                      DRIVER
      C          COMPUTE GRAV. ACCEL. G, G DIVIDED BY MUL. SCALE TEMP, TM,   DRIVER
      C          AND INTEGRAL OF G/TM AT ALTITUDE ZH2.                       DRIVER
      C                                                                      DRIVER
652         GG = GAF( ZH2 )                                                  DRIVER
654         GDTM = GDTMAF( ZH2 )                                             DRIVER
656         GDTMI = GTMIAF( ZH2 )                                            DRIVER
      C          COMPUTE PRESSURE AND DENSITY AT ALTITUDE ZH2                DRIVER
660         PP = PZ*EXP(-CC1*GDTMI + 9.4144E-08*ZH2**2.833)                  DRIVER
672         RHO = RTGMS*GDTM/RR*PP/GG                                        DRIVER
      C          COMPUTE M/MSTAR DAY AT ALTITUDE ZH2                         DRIVER
676         SF = SFDAF( ZH2 )                                                DRIVER
```

```
      BMBMS = 1.0/(1. + SF)                                           DRIVER,
C          COMPUTE TOTAL NUMBER DENSITY, N(1/CM**3) AT ALTITUDE ZH2   DRIVER,
      SN = BIGA/BIGMS*RHO/BMBMS                                       DRIVER,
C          COMPUTE TOTAL NUMBER DENSITY IF NO DISSOCIATION,           DRIVER,
C          NSTAR (1/CM**3)                                            DRIVER,
      SNS = BIGA*RHO/BIGMS                                            DRIVER,
      ODAYZ5 = 2.*SNS*SF                                              DRIVER,
      ONZI(5) = ODAYZ5                                                DRIVER,
      ONSCHI = ALOG(ONZI(2)/ONZI(1))/(ZION(2)-ZION(1))                DRIVER,
      DLOZ2Z = ONSCHI*ALOG10( EXP(1.0) )                              DRIVER,
      X(5) = DLOZ2Z                                                   DRIVER,
      X(6) = ALOG10(ONZI(2))                                          DRIVER,
      DO 135 I=3,5                                                    DRIVER,
      ZIM2ON(I) = ZION(I)-ZION(2)                                     DRIVER,
  135 CONTINUE                                                        DRIVER,
      DO 140 I=1,3                                                    DRIVER,
      ZII2 = ZIM2ON(I+2)                                              DRIVER,
      D(I,4) = ZII2*ZII2                                              DRIVER,
      DO 140 J=1,3                                                    DRIVER,
      D(I,4-J) = ZII2*D(I,5-J)                                        DRIVER,
  140 CONTINUE                                                        DRIVER,
      ZII5 = ZIM2ON(5)                                                DRIVER,
      D(4,4) = 2.*ZII5                                                DRIVER,
      DO 145 J=1,3                                                    DRIVER,
      FJ1 = J+1                                                       DRIVER,
      D(4,4-J) = ZII5*((FJ1+1.)/FJ1)*D(4,5-J)                         DRIVER,
  145 CONTINUE                                                        DRIVER,
      DO 150 I=1,3                                                    DRIVER,
      D(I,5) = ALOG10(ONZI(I+2)) - X(5)*ZIM2ON(I+2) - X(6)            DRIVER,
  150 CONTINUE                                                        DRIVER,
C          TO SET D(4,5) WE NEED THE DERIVATIVE OF ALOG10(SNI(3)) AT  DRIVER,
C          ALTITUDE ZION(5) = 90 KM, DLOZ5Z, GIVEN BY                 DRIVER,
C               DLOZ5Z = ALOG10( EXP(1.0) )*(D(SF)/DZ - 1.0/HRHO),    DRIVER,
C          EVALUATED AT Z5ON = ZION(5) = 90 KM.                       DRIVER,
C          COMPUTE DENSITY SCALE HEIGHT AT 90 KM.                     DRIVER,
      GDTM = GDTMAF( 90. )                                            DRIVER,
      HRO90 = 1.0/(CC1*GDTM - 2.6670995PE-07*90.**1.833               DRIVER,
     *        - 2.0/(RE+90.) - GKKZAF( 90. )/GDTM)                    DRIVER,
      Z5ON = ZION(5)                                                  DRIVER,
      DLOZ5Z = ALOG10( EXP(1.0) )*(((((((((((12.*DD(13)*Z5ON          DRIVER,
     *        + 11.*DD(12))*Z5ON + 10.*DD(11))*Z5ON + 9.*DD(10))*Z5ON DRIVER,
     *        + 8.*DD(9))*Z5ON + 7.*DD(8))*Z5ON + 6.*DD(7))*Z5ON      DRIVER,
     *        + 5.*DD(6))*Z5ON + 4.*DD(5))*Z5ON + 3.*DD(4))*Z5ON      DRIVER,
     *        + 2.*DD(3))*Z5ON + DD(2)) - 1.0/HRO90                   DRIVER,
      D(4,5) = DLOZ5Z-X(5)                                            DRIVER,
      NO = 4                                                          DRIVER,
      CALL SOLVE(D,X,NO)                                              DRIVER,
C          TO PROVIDE A CONTINUOUS TRANSITION IN THE CO2 DENSITY BETWEEN DRIVER,
C          THE ALTITUDE OF 100 KM, BELOW WHICH A CONSTANT MIXING RATIO  DRIVER,
C          IS ASSUMED, AND THE ALTITUDE OF 120 KM, AT WHICH THE ATMOSU  DRIVER,
C          HIGH-ALTITUDE MODEL (BASED ON DIFFUSIVE EQUILIBRIUM) BEGINS, DRIVER,
C          WE USE THE POLYNOMIAL                                      DRIVER,
C               LOG10(SNI(6)) = SUM( XC(I)*ZMICO2**(7-I)), I=1,7      DRIVER,
C          WHERE THE CONSTANTS XC(I),I=1,7 , ARE DETERMINED SO THAT THE DRIVER,
C          SLOPE OF ALOG10(SNI(6)) AT ZICO2(1) = 100 KM, DLCZ1Z, AND  DRIVER,
C          AT ZICO2(5) = 120 KM, DLCZ5Z, IS CONTINUOUS AND ALOG10(SNI(6))DRIVER,
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AD-A048 013 GENERAL RESEARCH CORP SANTA BARBARA CALIF F/G 4/1
THE ROSCOE MANUAL. VOLUME 14A. AMBIENT ATMOSPHERE (MAJOR AND MI--ETC(U)
JUN 75 D A HAMLIN, M R SCHOONOVER DNA001-74-C-0182
UNCLASSIFIED DNA-3964F-14A NL

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      C           EQUALS THE VALUES FOR CO2 AT ZICO2(I) = 100,105,110,115, AND
      C           120 KM FOR I=1,5 .
      C           THE CO2 CONSTANTS ARE NOW SET...
1124        DO 160 I=1,5
1133        ZICO2(I) = ALTKM(I+20)
1134        CO2ZI(I) = CO2(I+20)
1135    160 CONTINUE
      C           RESET CO2ZI(1) TO THE VALUE OBTAINED FROM THE LOW-ALTITUDE
      C           MODEL AT ALTITUDE ZICO2(1) = 100 KM. TO DO THIS WE MUST FIRST
      C           COMPUTE GRAV. ACCEL. G, G DIVIDED BY MOL. SCALE TEMP. TM, AND
      C           INTEGRAL OF G/TM AT 100 KM.
      C           COMPUTE GRAV. ACCEL. G, G DIVIDED BY MOL. SCALE TEMP. TM, AND
      C           INTEGRAL OF G/TM AT 100 KM
1136        GG = GAF( 100. )
1140        GDTM = GDTMAF( 100. )
1142        GDTMI = GTMIAF( 100. )
      C           COMPUTE PRESSURE AND DENSITY AT 100 KM
1144        PP = PZ*EXP(-CC1*GDTMI + 9.4144E-08*100.**2.833)
1157        RHO = BIGMS*GDTM/RR*PP/GG
      C           COMPUTE TOTAL NUMBER DENSITY IF NO DISSOCIATION,
      C           NSTAR, AT 100 KM.
1162        SNS = BIGA*RHO/BIGMS
1164        CO2ZI(1) = 3.20E-04 * SNS
1166        XC(7) = ALOG10(CO2ZI(1))
      C           THE SLOPE OF ALOG10(SNI(6)) AT ALTITUDE ZICO2(1) = 100 KM,
      C           DLCZIZ, IS GIVEN BY DLCZIZ = ALOG10(EXP(1.0))*((1./RHO)
      C           *(D(RHO)/DZ)) = ALOG10(EXP(1.0))*(-1./HRHO).
      C           COMPUTE DENSITY SCALE HEIGHT AT 100 KM.
1170        HRO100 = 1.0/(CC1*GDTM - 2.66709952E-07*100.**1.833
           *          - 2.0/(RE+100.) - GKKZAF( 100. )/GDTM)
1210        DLCZIZ = (-1.0/HRO100)*ALOG10( EXP(1.0) )
1216        XC(6) = DLCZIZ
1220        DO 164 I=2,5
1226        ZIMIC(I) = ZICO2(I)-ZICO2(1)
1230    164 CONTINUE
1231        DO 165 I=1,4
1234        ZII2 = ZIMIC(I+1)
1235        D(I,5) = ZII2*ZII2
1236        DO 165 J=1,4
1242        D(I,5-J) = ZII2*D(I,6-J)
1250    165 CONTINUE
1253        ZII5 = ZIMIC(5)
1254        D(5,5) = 2.*ZII5
1256        DO 170 J=1,4
1264        FJ1 = J+1
1266        D(5,5-J) = ZII5*((FJ1+1.)/FJ1)*D(5,6-J)
1300    170 CONTINUE
1301        DO 175 I=1,4
1304        D(I,6) = ALOG10(CO2ZI(I+1)) - XC(6)*ZIMIC(I+1) - XC(7)
1314    175 CONTINUE
1316        DLCZ5Z = ALOG10( EXP(1.0) )*TAU*(SA+SMI(6)*GAMT)/(SA-1.0)
1332        D(5,6) = DLCZ5Z-XC(6)
1333        NO = 5
1335        CALL SOLVE(D,XC,NO)
      C           COMPUTE N2 DENSITY AT 230-KM ALTITUDE FOR USE IN N-DENSITY
      C           INITIALIZATION IN SUBROUTINE SPCMIN.
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```
1337          ZZ = RE120*(ALTKM(47)-120.)/(RE+ALTKM(47))
1343          ETZ = EXP(-TAU*ZZ)
1351          TTDTZ = ( TIF-(TIF-TZ)*ETZ )/TZ
1355          GAM = GAMT*SMT(1)
1357          ALGAM1 = ALP(1)+GAM+1.0
1361          S1Z2N = SNIZ(1)*ETZ**GAM/TTDTZ**ALGAM1
      C            EVALUATE ATMOSPHERIC PROPERTIES AT 90-KM ALTITUDE PRIOR
      C            TO INITIALIZING IONOSU.
1371          ZHSAVE = ZH
1372          ZH = 90.
1374          JUMP = 0
1375          GO TO 210
1375      177 JUMP = 2
      C            INITIALIZE IONOSU ROUTINE.
1376          CALL IONOSU(1,ZH)
1402          ZH = ZHSAVE
      C            SET ZHFLAG  (ARBITRARY NEGATIVE VALUE)
1402          ZHFLAG = -20.
1404          RETURN
1404      200 CONTINUE
1404          IF( ZH.EQ.ZHFLAG )  RETURN
      CCC
      C            AN ERRONEOUS CONDITION WILL OCCUR IF IONOSU OR SPCMIN IS
      C            CALLED WITH JJ=2 AND A GIVEN VALUE OF ZH IF ATMOSU HAS NOT
      C            BEEN CALLED FIRST WITH JJ=2 AND FOR THE SAME VALUE OF ZH.
      C            THE VARIABLE ZHFLAG IS USED TO DETECT THIS CONDITION AND
      C            TO MAKE THE REQUIRED CALL TO ATMOSU.
      C            ZHFLAG IS INITIALIZED TO AN ARBITRARY NEGATIVE VALUE IN
      C            THE INITIALIZATION CALL TO ATMOSU.
      CCC
1407          ZHFLAG = ZH
1410      210 CONTINUE
1410          REZHI = 1.0/( RE+ZH )
1412          IF( ZH .GE. 120. )  GO TO 250
      C
      CCCCCC       LOW-ALTITUDE MODEL (ZH .LT. 120.)
      C
      C            COMPUTE GRAV. ACCEL. AT ALTITUDE ZH,    GG(CM/SEC**2).
1415          GG = GAF( ZH )
      C            COMPUTE GRAV. ACCEL. DIVIDED BY MOLECULAR-SCALE TEMPERATURE.
1416          GDTM = GDTMAF( ZH )
      C            COMPUTE INTEGRAL OF G/TM.
1420          GDTMI = GTMIAF( ZH )
      C             COMPUTE FUNCTION NEEDED FOR DENSITY SCALE HEIGHT
1422          GKKZ = GKKZAF( ZH )
      C            COMPUTE PRESSURE (DYNES/CM**2)
1424          PP = PZ*EXP(-CC1*GDTMI + 9.4144E-08*ZH**2.833)
      C            COMPUTE DENSITY (G/CM**3)
1436          RHO = BIGMS*GDTM/RR*PP/GG
      C            COMPUTE DENSITY SCALE HEIGHT (KM).
1442          IF (ZH .GE. 110.) GO TO 230
1446          HRHO = 1.0/(CC1*GDTM - 2.66709952E-07*ZH**1.833 - 2.0*REZHI
             *    - GKKZ/GDTM)
1460          GO TO 240
1462      230 ZHM110 = ZH - 110.
1463          HRHO = (EHR120*ZHM110 + 8B)*ZHM110 + HRO110
```

```
      C          USING DAY O PROFILE
1467    240 SF = SFDAF( ZH )
1472        BMBMS = 1.0/(1. + SF)
      C          COMPUTE TEMPERATURE (DEG K)
1474        TT = BMBMS*GG/GDTM
      C          COMPUTE NUMBER DENSITIES OF SPECIES.  WE PRESCRIBE THE
      C          DAY-NIGHT DEPENDENCE OF O AND USE THE LOW-ALTITUDE MODEL TO
      C          COMPUTE THE ASSOCIATED SLIGHT DAY-NIGHT DEPENDENCE OF O2 .
1477        SNS = BIGA*RHO/BIGMS
1501        SN = SNS/BMBMS
1502        SNI(1)  = 0.78*SNS
1504        SNI(2)  = 1.211*SNS - SN
1506        SNI(3) = 2.*SNS*SF
1510        IF( IDURN.GE.0 )  GO TO 245
      C          COMPUTE NIGHTTIME VALUE OF O
1512        IF( ZH.GE.Z5UN )  GO TO 245
1514        IF( ZH-ZION(2) )  242,242,241
1517    241 ZM2ON = ZH-ZION(2)
1520        SNI(3) = 10.**(((((X(1)*ZM2ON + X(2))*ZM2ON + X(3))*ZM2ON
           *         + X(4))*ZM2ON + X(5))*ZM2ON + X(6))
1534        GO TO 245
1535    242 IF( ZH-ZION(1) )  244,243,243
1540    243 ZM2ON = ZH-ZION(2)
1542        SNI(3) = ONZI(2)*EXP(ZM2ON*ONSCHI)
1547        GO TO 245
1551    244 SNI(3) = ONZI(1)
1553    245 SNI(4)  = 0.009*SNS
1555        SNI(5)  = 4.625E-05*SNS
1556        IF( ZH.LE.100. )  GO TO 24
1562        ZM1CO2 = ZH-ZICO2(1)
1563        SNI(6) = 10.**((((((XC(1)*ZM1CO2 + XC(2))*ZM1CO2 + XC(3))*ZM1CO2
           *         + XC(4))*ZM1CO2 + XC(5))*ZM1CO2 + XC(6))*ZM1CO2 + XC(7))
1601        GO TO 247
1602    246 SNI(6) = 3.20E-04 * SNS
      C          COMPUTE FRACTIONAL ERROR FROM HYDROSTATIC EQUILIBRIUM...
      C          FEHSEQ = -1.0E-05*DPPDZH/(RHO*GG) - 1.0
      C                 = -2.66709952E-12 * RR * ZH**1.833 / (BIGMS * GDTM)
      C          WHERE    2.66709952E-12 = 1.0E-05 * 2.833 * 9.4144E-08
1604    247 FEHSEQ = -2.66709952E-12 * RR * ZH**1.833 / (BIGMS * GDTM)
1613        IF( JUMP.EQ.0 )  GO TO 177
1615        RETURN
      C
      CCCCCC     HIGH-ALTITUDE MODEL (ZH .GE. 120.)
      C
      C          COMPUTE THE GEOPOTENTIAL ALTITUDE ABOVE 120 KM, ZZ(KM).
1615    250 CONTINUE
1615        ZZ = RE120*(ZH-120.)*REZHI
      C          COMPUTE THE TEMPERATURE AT THE GEOPOTENTIAL ALTITUDE,TT(DEG K)
1620        ETZ = EXP(-TAU*ZZ)
1625        TT = TIF - (TIF-TZ)*ETZ
      C          COMPUTE RATIO OF TEMPERATURE TO TEMPERATURE AT 120 KM.
1630        TTDTZ = TT/TZ
1630        PP = 0.0
1631        RHO = 0.0
1632        DRUDZN = 0.0
1633        DPPDZH = 0.0
```

```
1634          DO 260 I=1,IS                                                      DRIVER,751
       C           COMPUTE GAMMA-SUB-I.                                          DRIVER,752
1646          GAM = GAMT*SMI(I)                                                  DRIVER,753
1647          ALGAM1 = ALP(I) + GAM + 1.0                                        DRIVER,754
       C           COMPUTE DENSITIES (1/CM**3) OF N2, O2, O, AR, HE, AND CO2.    DRIVER,755
1651          SNI(I) = SNIZ(I)*ETZ**GAM / TTOTZ**ALGAM1                          DRIVER,756
       C           COMPUTE TOTAL NUMBER DENSITY (1/CM**3).                       DRIVER,757
1661          PP = PP + SNI(I)                                                   DRIVER,758
       C           COMPUTE TOTAL MASS DENSITY (G/CM**3).                         DRIVER,759
1663          RHO = RHO + SMI(I)*SNI(I)                                          DRIVER,760
       C           COMPUTE A PORTION OF THE SPATIAL DERIVATIVE OF THE DENSITY.   DRIVER,761
1664          SGAFT = SNI(I)*(GAM + ALGAM1*ETZ*(TIF-TZ)/TT)                      DRIVER,762
1671          DRODZN = DRODZN + SGAFT*SMI(I)                                     DRIVER,763
       C           COMPUTE A PORTION OF THE SPATIAL DERIVATIVE OF THE PRESSURE.  DRIVER,764
1673      260 DPPDZH = DPPDZH + SGAFT                                            DRIVER,765
       C           COMPUTE SPATIAL DERIVATIVE OF PRESSURE.                       DRIVER,766
1675          DPPDZH = ( GAF( ZH )/GAMT ) *(SA*PP*ETZ - TT*DPPDZH/TIF)           DRIVER,767
       C           COMPUTE FRACTIONAL ERROR FROM HYDROSTATIC EQUILIBRIUM.        DRIVER,768
1707          FEHSEQ = -(DPPDZH/(RHO*GAF( ZH )) + 1.0)                           DRIVER,769
       C           COMPUTE PRESSURE (DYNES/CM**2).                               DRIVER,770
1714          PP = PP*TT*SK                                                      DRIVER,771
       C           COMPUTE DENSITY SCALE HEIGHT (KM).                            DRIVER,772
1716          DRODZN = DRODZN*TAU*(RE120-ZZ)*REZHI                               DRIVER,773
1722          HRHO = RHO/DRODZN                                                  DRIVER,774
1724          RETURN                                                             DRIVER,775
1724          END                                                                DRIVER,776
```

BLKCHM

```
      BLOCK DATA BLKCHM                                                 DRIVER.777
C                                                                       DRIVER.778
      COMMON/CHEMR/  AR(66),  BR(66),  CR(66)                           DRIVER.779
C     FOR REACTION I, RATE = AR(I)(T/300)**BR(I)*EXP(-CR(I)/T)          DRIVER.780
C                                                                       DRIVER.781
C                                                                       DRIVER.782
      DATA AR/5.0E-10,3.0E-10,1.0E-12,4.0E-11,8.0E-10,1.0E-12,4.4E-12,  DRIVER.783
     1        1.2E-19,2.0E-11,6.0E-14,4.4E-12,1.2E-19,1.0E-7,3.0E-7,    DRIVER.784
     2        2.1E-13,2.4E-13,1.2E-17,1.0E-17,3.3E-12,6.9E-12,2.7E-11,  DRIVER.785
     3        7.0E-11,1.3E-9,5.0E-10,2.5E-10,1.4E-29,2.7E-10,3.0E-10,   DRIVER.786
     4        1.4E-3,3.5E-31,2.1E-4,4.0E-10,4.4E-11,2.5E-10,1.8E-8,     DRIVER.787
     5        1.0E-11,5.0E-11,1.0E-11,6.2E-11,1.5E-11,8.3E-13,8.0E-10,  DRIVER.788
     6        2.3E-9,4.0E-11,1.5E9,4.0E-12,7.2E-11,2.0E-7,5.6E-26,      DRIVER.789
     7        3.2E-28,1.6E-7,1.0E-6,1.3E-4,1.0E-26,1.3E-15,2.0E-10,     DRIVER.790
     8        2.0E-10,2.2E-10,2.0E-17,5.6E-29,7.3E-9,5.0E-7,9.0E-12,    DRIVER.791
     9        6.4E-12,1.0E-12,6.2E-6/                                   DRIVER.792
C                                                                       DRIVER.793
      DATA BR/    0.0,     0.0,     0.0,      0.0,     0.0,     0.0,  -0.75,  DRIVER.794
     1          -5.0,    -0.5,   +2.,       -0.75,    -5.0,    -1.0,    -1.0,DRIVER.795
     2          +0.5,    +0.5,    -0.35,   -1.0,      1.,     +0.5,    0.0,  DRIVER.796
     3           0.0,     0.0,     0.0,     0.0 ,   -1.0,   +0.5,   0.0,     DRIVER.797
     4        -1.98,  -1.5,  -1.71,  0.0,  -0.23,  0.0,  -0.97,             DRIVER.798
     5        0.0,  +0.15,  0.0,  -0.09,  0.0,  +0.4,  0.0,                 DRIVER.799
     6        +0.02,  0.0,  +1.45,  0.0,  -0.4,  -0.5,  -1.5,               DRIVER.800
     7        -1.5,  -1.0,  0.0,  -3.0,  -2.5,  0.0,  0.0,                  DRIVER.801
     8        -1.0,  0.0,  +3.0,  -1.6,  -.03,  -1.0,  0.0,                 DRIVER.802
     9        -0.25,  0.0,  -1.5/                                           DRIVER.803
C                                                                       DRIVER.804
      DATA CR/    0.0,     0.0,     0.0, 20060.,    0.0,     0.0,     0.0,  DRIVER.805
     1            0.0,     0.0, -900.,      0.0,     0.0,     0.0,     0.0,  DRIVER.806
     2         31900.,  4300.,     0.0,      0.0,  3150.,     0.0,    0.0,   DRIVER.807
     3            0.0, 26000.,     0.0, 37900.,  600.,   5590.,  0.0,       DRIVER.808
     4        7194.,  0.0,  6230.,  0.0,  25423.,  0.0,  28338.,            DRIVER.809
     5        0.0,  27711.,  0.0,  28281.,  0.0,  2167.,  0.0,              DRIVER.810
     6        23769.,  0.0,  28776.,  0.0,  6113.,  0.0,  0.0,              DRIVER.811
     7        0.0,  54200.,  24600.,  22300.,  0.0,  0.0,  0.0,             DRIVER.812
     8        0.0,  0.0,        4600.,  600.,  51429.,  0.0,  0.0,          DRIVER.813
     9         23200.,  0.0,  3900./                                        DRIVER.814
C                                                                       DRIVER.815
      END                                                               DRIVER.816
```

FITTER

```
      SUBROUTINE FITTER(NPTS,X,Y,NO,IKIND,ISIGN,Z)
CCC
C          SUBROUTINE FITTER USES THE METHOD OF LEAST SQUARES TO COMPUTE
C          THE COEFFICIENTS, Z(J),J=1,NO IN A POLYNOMIAL OF DEGREE NO
C          REPRESENTING THE DEPENDENT VARIABLE Y(I) (OR, OPTIONALLY, ITS
C          NATURAL LOGARITHM) SPECIFIED (AND GIVEN EQUAL WEIGHTS) AT
C          NPTS VALUES OF THE INDEPENDENT VARIABLE X(I).
CCC
C     INPUT PARAMETERS
C               NPTS - NUMBER OF DATA POINTS
C               X(I) - VALUES OF THE INDEPENDENT VARIABLE, E.G.,
C                      ALTITUDE, KM
C               Y(I) - VALUES OF THE DEPENDENT VARIABLE, E.G., SPECIES
C                      CONCENTRATION, 1./CM**3
C                 NO - DEGREE OF POLYNOMIAL TO BE FITTED
C              IKIND - INDEX FOR KIND OF EQUATION TO BE FITTED
C                    = 1 IF EQUATION IS
C                        LN(Y) = A0 + A1*X + A2*X**2 + ... + AN*X**N
C                    = 2 IF EQUATION IS
C                          Y   = A0 + A1*X + A2*X**2 + ... + AN*X**N
C              ISIGN - INDEX FOR SIGN OF EXPONENTS
C                    = 1  FOR NEGATIVE EXPONENTS
C                    = 2  FOR POSITIVE EXPONENTS
CCC
C     OUTPUT PARAMETERS
C               Z(J) - THE LEAST-SQUARES FIT COEFFICIENTS.
C                      Z(1) CORRESPONDS TO A0, Z(2) TO A1, ETC.
CCC
      DIMENSION  A(20,21), X(100), Y(100), Z(20)
      NO1 = NO+1
      NO2 = NO+2
      DO 9 I=1,NO1
      DO 9 J=1,NO2
      A(I,J) = 0.
    9 CONTINUE
      DO 20 I=1,NPTS
      R = Y(I)
      A(1,1) = A(1,1) + 1.0
      GO TO (10,12), IKIND
   10 R = ALOG(R)
   12 S = X(I)
      GO TO (14,16), ISIGN
   14 S = 1.0/S
   16 Q = 1.0
      A(1,NO2) = A(1,NO2) + R
      DO 18 J=2,NO1
      Q = Q*S
      A(1,J) = A(1,J) + Q
   18 A(J,NO2) = A(J,NO2) + Q*R
      DO 20 K=2,NO1
      Q = Q*S
   20 A(K,NO1) = A(K,NO1) + Q
      DO 30 I=2,NO1
      DO 30 J=1,NO
      A(I,J) = A(I-1,J+1)
   30 CONTINUE
      CALL SOLVE(A,Z,NO1)
      RETURN
      END
```

```
      SUBROUTINE IONOSU(JJ,ZH)                                          DRIVER.876
CCC                                                                     DRIVER.877
C         SUBROUTINE IONOSU PROVIDES THE PROPERTIES OF THE AMBIENT      DRIVER.878
C         IONOSPHERE REQUIRED BY ALL THE CHEMISTRY MODULES.             DRIVER.879
CCC                                                                     DRIVER.880
C         HOWEVER, THIS THIRD VERSION OF IONOSU IS LIMITED IN THAT THE  DRIVER.881
C         PROFILES OF IONOSPHERIC PROPERTIES ARE REPRESENTATIVE BUT     DRIVER.882
C         NOT NECESSARILY THE FINAL SELECTIONS.                         DRIVER.883
CCC                                                                     DRIVER.884
C         THE E- AND F-REGION CHEMISTRY MODULE REQUIRES...              DRIVER.885
C         (1) Q(1/(CM**3 SEC)) = EFQ, THE EFFECTIVE TOTAL ION           DRIVER.886
C             PRODUCTION RATE THAT REPRODUCES THE AMBIENT IONOSPHERE    DRIVER.887
C             WHEN USED WITH THE CHEMISTRY MODEL.                       DRIVER.888
C         (2) O+(1/CM**3) = EFOP, THE POSITIVE ATOMIC ION DENSITY.      DRIVER.889
C         (3) M+(1/CM**3) = EFMOLP, THE POSITIVE MOLECULAR ION DENSITY. DRIVER.890
C         (4) TX(DEG K), THE ELECTRON AND N2 VIBRATIONAL TEMPERATURE.   DRIVER.891
CCC                                                                     DRIVER.892
C         THE D-REGION CHEMISTRY MODULE REQUIRES...                     DRIVER.893
C         (1) Q(1/(CM**3 SEC)) = DQ, THE EFFECTIVE TOTAL ION PRODUCTION DRIVER.894
C             RATE THAT REPRODUCES THE AMBIENT IONOSPHERE WHEN USED WITHDRIVER.895
C             THE CHEMISTRY MODEL.                                      DRIVER.896
CCC                                                                     DRIVER.897
C         INPUT PARAMETERS                                              DRIVER.898
C            ARGUMENT LIST                                              DRIVER.899
C                JJ - CALCULATION FLAG                                  DRIVER.900
C                     = 1, CALCULATE INITIALIZATION PARAMETERS          DRIVER.901
C                     = 2, CALCULATE IONOSPHERIC PROPERTIES             DRIVER.902
C                ZH - ALTITUDE OF INTEREST (KM)                         DRIVER.903
C            ATMOUP COMMON                                              DRIVER.904
C                     IDORN, SNI(1), SNI(2), SNI(3), TT                 DRIVER.905
C            ALTODN COMMON                                              DRIVER.906
C                     ALTKM(47)                                         DRIVER.907
C            RATE FUNCTION                                              DRIVER.908
C                     RATE                                              DRIVER.909
C         OUTPUT PARAMETERS                                             DRIVER.910
C            ATMOUP COMMON                                              DRIVER.911
C                     SNI( 9), SNI(10), SNI(11), SNI(12)                DRIVER.912
C            IONOUP COMMON                                              DRIVER.913
C                     EFE,EFOP,EFMOLP,TX,QDEF                           DRIVER.914
C            VARIABLES IN IONOUP                                        DRIVER.915
C                 EFE=SNI( 9) - ELECTRON DENSITY IN E- AND              DRIVER.916
C                               F-REGION, 1/CM**3                       DRIVER.917
C                EFOP=SNI(10) - ATOMIC OXYGEN ION DENSITY IN E- AND     DRIVER.918
C                               F-REGION, 1/CM**3                       DRIVER.919
C              EFMOLP=SNI(11) - MOLECULAR ION DENSITY IN E- AND         DRIVER.920
C                               F-REGION, 1/CM**3                       DRIVER.921
C                  TX=SNI(12) - ELECTRON AND N2 VIBRATIONAL             DRIVER.922
C                               TEMPERATURE, DEG K                      DRIVER.923
C                        QDEF - EFFECTIVE TOTAL ION PRODUCTION RATE,    DRIVER.924
C                               1/(CM**3 SEC)                           DRIVER.925
CCC                                                                     DRIVER.926
C         THE REQUIRED QUANTITIES FOR THE E- AND F-REGION CHEMISTRY ARE DRIVER.927
C         OBTAINED AS FOLLOWS...                                        DRIVER.928
C         (1) EFQ IS COMPUTED FROM A MODIFIED FORM OF EQ.(2-276) OF     DRIVER.929
C             DASA 2497-1 (GE-70)..                                     DRIVER.930
C             EFQ = EFALPD*EFE*EFE*(1.0 + EFALPR*EFE/EFBETA)/(1.0 +     DRIVER.931
```

```
C                 (EFALPD*EFSF + EFALPR*(1.-EFSF)*EFE/EFBETA)
C             WHERE
C             EFE = ELECTRON DENSITY PROVIDED AS INPUT DATA TO
C                   IONOSU   (1/CM**3)
C            EFSF = SNI(3)/(SNI(3) + 2.*(SNI(1)+SNI(2)))
C          SNI(1) = N2 CONCENTRATION
C          SNI(2) = O2 CONCENTRATION
C          SNI(3) = O  CONCENTRATION
C          EFALPD = DISSOCIATIVE RECOMBINATION RATE COEFFICIENT FOR
C                   THE REACTION M+ + E = PRODUCTS   (CM**3/SEC)
C                 = RATE(13,TX) + RATE(14,TX)  WHERE RATE(INDX,TEM) IS
C                   THE FUNCTION ROUTINE FOR E- AND F-REGION RATE
C                   COEFFICIENTS,  (CM**3/SEC)
C          EFBETA = RATE(10,TX)*SNI(1) + RATE(9,TT)*SNI(2)   (1/SEC)
C     RATE(10,TX) = REACTION RATE COEFFICIENT FOR THE REACTION
C                   O+ + N2 = NO+ + N
C     RATE( 9,TT) = REACTION RATE COEFFICIENT FOR THE REACTION
C                   O+ + O2 = O2+ + O
C       (2) EFOP IS COMPUTED FROM A MODIFIED FORM OF EQ.(2-274) OF
C           DASA 2497-1 (GE-70)..
C           EFOP = EFSF*EFQ/(EFBETA + EFALPR*EFE)
C           WHERE
C          EFALPR = EFFECTIVE TWO-BODY COLLISIONAL-RADIATIVE RECOMBINA-
C                   TION RATE COEFFICIENT FOR ATOMIC IONS
C                 = RATE(11,TX) + RATE(12,TX)*EFE + 1.5E-07*SQRT(EFE)/
C                   TX**3 (CM**3/SEC)
C       (3) EFMOLP IS COMPUTED FROM A MODIFIED FORM OF EQ.(2-275) OF
C           DASA 2497-1 (GE-70).
C         EFMOLP =  ((1.-EFSF)*EFQ + EFBETA*EFE)/(EFALPD*EFE + EFBETA)
C       (4) TX(DEG K) IS COMPUTED FROM AN ITERIM PRESCRIPTION.
CCC
C       ELECTRON DENSITY PROFILES FOR NOMINAL MIDLATITUDE DAYTIME AND
C       NIGHTTIME CONDITIONS IN THE E- AND F-REGIONS ARE PROVIDED AS
C       APPROXIMATE FITS TO CURVES IN FIG. 1 OF H. RISHBETH, PHYSICS
C       AND CHEMISTRY OF THE IONOSPHERE, CONTEMP. PHYSICS, VOL. 14,
C       P. 229(1973) (RI-73).
CCC
C       FOR DAYTIME ELECTRON DENSITY...
CCC
C       ASSUME PARABOLIC INCREASE IN LOG OF ELECTRON DENSITY FROM
C       ALOG10(EBOTD) = 5.0 AT ALTITUDE HEBOTD = 100.0 KM TO
C       ALOG10(EF2MXD) = ALOG10(7.5E+05) AT ALTITUDE HF2MXD = 300. KM.
C       FOLLOWED AT HIGHER ALTITUDE BY EXPONENTIAL DECREASE WITH
C       SCALE HEIGHT F2DSCH = 200. KM.  BELOW ALTITUDE HEBOTD, ASSUME
C       EXPONENTIAL DECREASE WITH SCALE HEIGHT EODSCH = 5.0 KM.
C
C       IF(ZH.GT.HF2MXD)  EFE = EF2MXD*EXP((HF2MXD-ZH)/F2DSCH)
C       IF(ZH.GE.EBOTD .AND. ZH.LE.HF2MXD)
C       EFE = EF2MXD*10.**(EFEA*(HF2MXD-ZH)**2)
C       WHERE THE COEFFICIENT EFEA IS DETERMINED SO THAT EFE = EBOTD
C       AT ALTITUDE HEBOTD,
C       I.E., EFEA = ALOG10(EBOTD/EF2MXD)/(HF2MXD-HEBOTD)**2
C       WITH
C          HF2MXD = ALTITUDE OF F2MAX IN DAYTIME,  KM
C          EF2MXD = ELECTRON DENSITY AT F2MAX IN DAYTIME,  1/CM**3
C           EBOTD = ELECTRON DENSITY AT HEBOTD,  1/CM**3
```

```
C          IF(ZH.LT.HEBOTD)  EFE = EBOTD*EXP((ZH-HEBOTD)/EDDSCH)
CCC
C          FOR NIGHTTIME ELECTRON DENSITY...
CCC
C          ASSUME SINUSOID INCREASE IN LOG OF ELECTRON DENSITY FROM
C          ALOG10(EBOTN) = 3.0 AT ALTITUDE HEBOTN = 100. KM TO
C          ALOG10(EF2MXN) = ALOG10(4.0E+05) AT ALTITUDE HF2MXN = 360. KM,
C          FOLLOWED AT HIGHER ALTITUDE BY EXPONENTIAL DECREASE WITH SCALE
C          HEIGHT F2NSCH = 200. KM.  BELOW HEBOTN, ASSUME EXPONENTIAL
C          DECREASE WITH SCALE HEIGHT EDNSCH = 5.0 KM.
C          IF(ZH.GT.HF2MXN)  EFE = EF2MXN*EXP((HF2MXN-ZH)/F2NSCH)
C          IF(ZH.GE.EBOTN .AND. ZH.LE.HF2MXN)
C          ALOG10(EFE) = ALOG10(EBOTN) + 0.50*ALOG10(EF2MXN/EBOTN)
C                    * (1.0+SIN(PID2*(2.*ZH-HEBOTN-HF2MXN)/
C                      (HF2MXN-HEBOTN)))
C          IF(ZH.LT.HEBOTN)  EFE = EBOTN*EXP((ZH-HEBOTN)/EDNSCH)
CCC
C          ELECTRON TEMPERATURE PROFILES IN THE E- AND F-REGION ARE
C          OBTAINED, FOR (NOON) DAYTIME CONDITIONS, BY PRESCRIBING THE
C          DIFFERENCE BETWEEN THE ELECTRON TEMPERATURE TX AND THE GAS
C          TEMPERATURE TT AT  TWO  ALTITUDES AND USING A PARABOLIC FIT
C          TO THIS DIFFERENCE.  FOR NIGHTTIME CONDITIONS, WE ASSUME TX=TT
CCC
C          FOR DAYTIME ELECTRON TEMPERATURE...
C          ALTITUDE, KM       TX-TT, DEG K      TT(CIRA-65, MODEL-5, 8-HR)
C
C             120               0 = TXT120                335
C             200             500 = TXT200                933
CCC
C          THESE VALUES OF TX-TT ARE CONSISTENT WITH THE VALUES OF TX
C          REPORTED BY J.V. EVANS (MILLSTONE HILL THOMSON SCATTER RESULTS
C          FOR 1966 AND 1967, PLANET. SPACE SCI.  VOL. 21, PP. 763-792
C          (1973), (EV-73))  AND THE CIRA-1965 MODEL-5 8-HR ATMOSPHERE
C          (CI-65).
C
C          IF(ZH.LT.120.)  TX = TT
C          IF(ZH.GE.120.)  TXT = SQRT( ZHM120/A )
C          WHERE
C             ZHM120 = ZH-120.
C                  A = 80. / 500.**2
CCC
C          THE REQUIRED QUANTITY FOR THE D-REGION CHEMISTRY IS OBTAINED
C          AS FOLLOWS...
C          DQ IS FORCED TO EQUAL THE VALUE OF EFQ AT THE BOTTOM OF THE
C          GRID (90-KM) AND IS DETERMINED BY INPUT DATA AT LOWER
C          ALTITUDES.
C           NOTE ...  QDEF = DQ OR QDEF = EFQ DEPENDING ON THE
C                     ALTITUDE ZH.
CCC
C          FOR DAYTIME...
C
C          IF(ZH.LE.60.)
C                DQ = DQDAY(7) * QD1307**(ZHMZ07/Z13M07)
C            QD1307 = DQDAY(13)/DQDAY(7)
C            ZHMZ07 = ZH-ALTKM(7)
C            Z13M07 = ALTKM(13)-ALTKM(7)
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```
      C           IF(60..LT.ZH .AND. ZH.LT.90)
      C                 DQ = DQDAY(13) * QD1913**(ZHM713/Z19M13)
      C             QD1913 = FFQZ19/DQDAY(13)
      C             ZHM713 = ZH-ALTKM(13)
      C             Z19M13 = ALTKM(19)-ALTKM(13)
      CCC
      C           FOR NIGHTTIME...
      C
      C           IF(ZH.LE.60.)
      C                 DQ = DQNIT(7) * QN1307**(ZHMZ07/Z13M07)
      C             QN1307 = DQNIT(13)/DQNIT(7)
      C
      C           IF(60..LT.ZH .AND. ZH.LT.90.)
      C                 DQ = DQNIT(13) * QN1913**(ZHM713/Z19M13)
      C             QN1913 = FFQZ19/DQNIT(13)
      CCC
            DIMENSION  DQDAY(18),DQNIT(18)
            COMMON/ATMOUP/  HL,SBAR,IDURN,PP,RHO,TT,SNI(16),HRHO,FEHSFQ
            COMMON/IONOUP/  EFE,EFUP,EFMOLP,TX,QDFF
            COMMON/ALTODN/  NALTOD,ALTKM(47),ODAY(27),UNITE(18),S1Z2N,CO2(25)
            COMMON/ZHCHEX/  ZHFLAG
      CCC
            DATA  EBOTD,HEBOTD,EF2MXD,HF2MXD,F2DSCH,EDDSCH /  1.0E+05,1.0E+02,
           *  7.0E+05,3.0E+02,2.0E+02,5.0 /
            DATA  EBOTN,HEBOTN,EF2MXN,HF2MXN,F2NSCH,EDNSCH /  1.0E+03.1.0E+02,
           *  4.0E+05,3.6E+02,2.0E+02,5.0 /
            DATA  TXT120,TXT200,TXT800 / 0.0,5.0E+02,1.8E+03 /
            DATA  PI / 3.14159265359O /
      C           INTERIM VALUES 06/10/75
            DATA (DQDAY(I),I=1,18)/6*0.,3.3,5*0.,0.06,5*0./
      C           INTERIM VALUES 06/10/75
            DATA (DQNIT(I),I=1,18)/6*0.,3.3,5*0.,0.06,5*0./
      CCC
            GO TO (100,200), JJ
      C           INITIALIZATION, CALLED FROM SUBROUTINE ATMUSU DURING ITS
      C           INITIALIZATION.
11      100 CONTINUE
11          PID2 = PI/2.
13          H2PBD2 = 0.50*(HF2MXN+HEBOTN)
16          H2MBD2 = 0.50*(HF2MXN-HEBOTN)
20          ALG2D1 = 0.50*ALOG10(EF2MXN/EBOTN)
24          EFEA = ALOG10(EBOTD/EF2MXD)/(HF2MXD-HEBOTD)**2
34          A = 80. / (500.*500.)
      C           INITIALIZATION FOR D-REGION Q...
      C           COMPUTE ELECTRON TEMPERATURE AT 90-KM ALTITUDE
36          TX = TT
37          IF(IDORN.LT.0) GO TO 150
      C           COMPUTE DAYTIME ELECTRON DENSITY AT 90 KM
42          EFE = EBOTD * EXP( (90.-HEBOTD)/EDDSCH)
51          GO TO 180
      C           COMPUTE NIGHTTIME ELECTRON DENSITY AT 90-KM ALTITUDE
53      150 EFE = EBOTN * EXP((90. - HEBOTN)/EDNSCH)
63      180 EFALPD = RATE (13,TX) + RATE (14,TX)
72          EFALPR = RATE(11,TX)+RATE(12,TX)*EFE+1.5E-07*SQRT(EFE)/TX**3
110         EFSF   = SNI(3)/(SNI(3) + 2.*(SNI(1) + SNI(2)))
114         EFBETA = RATE(10,TX)*SNI(1) + RATE(9,TT)*SNI(2)
```

```
      EFQZ19 = EEALPD*EFE*EFE*(1.0 + EEALPR*EFE/EEBETA) /                DRIVER,1100
     *            (1.0 + (EEALPD*EFSF + EEALPR*(1.-EFSF))*EFE/EEBETA)     DRIVER,1101
      IF(IDORN.LT.0) GO TO 190                                           DRIVER,1102
      QD1913 = EFQZ19/DQDAY(13)                                          DRIVER,1103
      QD1307 = DQDAY(13)/DQDAY(7)                                        DRIVER,1104
      GO TO 195                                                          DRIVER,1105
  190 QN1913 = EFQZ19/DQNIT(13)                                          DRIVER,1106
      QN1307 = DQNIT(13)/DQNIT(7)                                        DRIVER,1107
  195 CONTINUE                                                           DRIVER,1108
      Z19M13 = ALTKM(19)-ALTKM(13)                                       DRIVER,1109
      Z13M07 = ALTKM(13)-ALTKM(7)                                        DRIVER,1110
      RETURN                                                             DRIVER,1111
  200 CONTINUE                                                           DRIVER,1112
      IF( ZH.NE.ZHFLAG )  CALL ATMOSU(2,ZH)                              DRIVER,1113
CCC                                                                      DRIVER,1114
C          AN ERRONEOUS CONDITION WILL OCCUR IF IONOSU IS CALLED WITH    DRIVER,1115
C          JJ=2 AND A GIVEN VALUE OF ZH IF ATMOSU HAS NOT BEEN CALLED    DRIVER,1116
C          FIRST WITH JJ=2 AND FOR THE SAME VALUE OF ZH.                 DRIVER,1117
C          THE VARIABLE ZHFLAG IS USED TO DETECT THIS CONDITION AND      DRIVER,1118
C          TO MAKE THE REQUIRED CALL TO ATMOSU.                          DRIVER,1119
C          ZHFLAG IS INITIALIZED TO AN ARBITRARY NEGATIVE VALUE IN       DRIVER,1120
C          THE INITIALIZATION CALL TO ATMOSU.                            DRIVER,1121
CCC                                                                      DRIVER,1122
      IF(ZH.GE.90.) GO TO 205                                            DRIVER,1123
C          SET ELECTRON TEMPERATURE FOR ZH.LT.90.                        DRIVER,1124
      TX = TT                                                            DRIVER,1125
C          ZERO EFE, EFOP, AND EFMOLP FOR ZH.LT.90.                      DRIVER,1126
      EFE = EFOP = EFMOLP = 0.0                                          DRIVER,1127
C          PROCEED WITH DQ CALCULATION FOR ZH.LT.90.                     DRIVER,1128
      IF(IDORN.LT.0) GO TO 350                                           DRIVER,1129
C          COMPUTE DAYTIME DQ                                            DRIVER,1130
      IF(ZH.LE.60.) GO TO 325                                            DRIVER,1131
C          COMPUTE DAYTIME DQ FOR 60.LT.ZH.LT.90.                        DRIVER,1132
      ZHMZ13 = ZH-ALTKM(13)                                              DRIVER,1133
      DQ = DQDAY(13) * QD1913**(ZHMZ13/Z19M13)                           DRIVER,1134
      GO TO 385                                                          DRIVER,1135
  325 CONTINUE                                                           DRIVER,1136
C          COMPUTE DAYTIME DQ FOR ZH.LE.60.                              DRIVER,1137
      ZHMZ07 = ZH-ALTKM(7)                                               DRIVER,1138
      DQ = DQDAY(7) * QD1307**(ZHMZ07/Z13M07)                            DRIVER,1139
      GO TO 385                                                          DRIVER,1140
  350 CONTINUE                                                           DRIVER,1141
C          COMPUTE NIGHTTIME DQ                                          DRIVER,1142
      IF(ZH.LE.60.) GO TO 375                                            DRIVER,1143
C          COMPUTE NIGHTTIME DQ FOR 60.LT.ZH.LT.90.                      DRIVER,1144
      ZHMZ13 = ZH-ALTKM(13)                                              DRIVER,1145
      DQ = DQNIT(13) * QN1913**(ZHMZ13/Z19M13)                           DRIVER,1146
      GO TO 385                                                          DRIVER,1147
  375 CONTINUE                                                           DRIVER,1148
C          COMPUTE NIGHTTIME DQ FOR ZH.LE.60.                            DRIVER,1149
      ZHMZ07 = ZH-ALTKM(7)                                               DRIVER,1150
      DQ = DQNIT(7) * QN1307**(ZHMZ07/Z13M07)                            DRIVER,1151
  385 DQEF = DQ                                                          DRIVER,1152
      SNI( 9) = 0.0                                                      DRIVER,1153
      SNI(10) = 0.0                                                      DRIVER,1154
      SNI(11) = 0.0                                                      DRIVER,1155
```

```
250         SNI(12) = TX
252         RETURN
      CCC
253     205 IF( IDURN.LT.0 ) GO TO 250
      CCC
      C           COMPUTE DAYTIME ELECTRON DENSITY AND TEMPERATURE OF
      C           E- AND F-REGIONS.
      CCC
      C           ELECTRON DENSITY
255         IF( ZH-HEBOTD )  210,212,212
257     210 EFE = EBOTD * EXP((ZH-HEBOTD)/EDDSCH)
265         GO TO 220
267     212 IF( ZH-HF2MXD )  214,214,216
272     214 EFE = EF2MXD * 10.**(FFEA*(HF2MXD-ZH)**2)
302         GO TO 220
302     216 EFE = EF2MXD * EXP((HF2MXD-ZH)/F2DSCH)
      C           ELECTRON TEMPERATURE
311     220 IF( ZH-120. )  222,224,224
314     222 TX = TT
316         GO TO 280
316     224 ZHM120 = ZH-120.
320         TX = TT + SQRT( ZHM120/A )
325         GO TO 280
      CCC
      C           COMPUTE NIGHTTIME ELECTRON DENSITY AND TEMPERATURE OF
      C           E- AND F-REGIONS.
      CCC
      C           ELECTRON DENSITY
327     250 IF( ZH-HEBOTN )  260,262,262
332     260 EFE = EBOTN * EXP((ZH-HEBOTN)/EDNSCH)
340         GO TO 270
342     262 IF( ZH-HF2MXN )  264,264,266
345     264 EFE = EBOTN * 10.**( ALG2D1*(1.0+SIN(PID2*(ZH-H2PBD2)/H2MBD2)))
361         GO TO 270
363     266 EFE = EF2MXN * EXP((HF2MXN-ZH)/F2NSCH)
      C           ELECTRON TEMPERATURE
372     270 TX = TT
      CCC
      C           COMPUTE EFQ, EFOP, AND EFMOLP
      CCC
      C           EFQ
374     280 EFALPD = RATE(13,TX) + RATE(14,TX)
403         EFALPR = RATE(11,TX) + RATE(12,TX)*EFE + 1.5E-07*SQRT(EFE)/TX**3
421         EFSF = SNI(3)/(SNI(3) + 2.*(SNI(1)+SNI(2)))
425         EFBETA = RATE(10,TX) * SNI(1) + RATE(9,TT) * SNI(2)
441         EFQ = EFALPD*EFE*EFE*(1.0+EFALPR*EFE/EFBETA)/
           *       (1.0+(EFALPD*EFSF + EFALPR*(1.-EFSF))*EFE/EFBETA)
452         QDEF = EFQ
      C           EFOP
452         EFOP = EFSF*EFQ/(EFBETA + EFALPR*EFE)
      C           EFMOLP
455         EFMOLP = ((1.-EFSF)*EFQ + EFBETA*EFE)/(EFALPD*EFE + EFBETA)
463         SNI(9) = EFE
464         SNI(10) = EFOP
465         SNI(11) = EFMOLP
467         SNI(12) = TX
471         RETURN
471         END
```

```
            SUBROUTINE JULIAN(IYRS,IMONS,IDAYS,YREFJ,VEQJ,DAYJ)
      CCC
      C          SUBROUTINE JULIAN CONVERTS A GREGORIAN CALENDAR DATE TO
      C          JULIAN DAY NUMBER DAYJ FOR SUBROUTINE SOLORB.
      C          SUBROUTINE JULIAN IS VALID FOR YEARS 1901 TO 1999 INCLUSIVE.
      CCC
      C     INPUT PARAMETERS
      C               IYRS - NUMBER OF THE YEAR IN THE 1900 S (E.G., 1974
      C                      BECOMES 74).
      C              IMONS - NUMBER OF THE MONTH (E.G., FEBRUARY BECOMES 2).
      C              IDAYS - DAY OF THE MONTH
      CCC
      C     OUTPUT PARAMETERS
      C              YREFJ - JULIAN DAY NUMBER (A HALF INTEGER) AT 0 HRS UT
      C                      ON JANUARY 1 OF THE YEAR OF INTEREST.
      C               VEQJ - JULIAN DATE FOR VERNAL EQUINOX.
      C               DAYJ - JULIAN DAY NUMBER (A HALF INTEGER) AT 0 HRS UT
      C                      ON THE DAY OF INTEREST.
      CCC
      C     DEFINITION OF DATA
      C            DAYM(I) - THE CUMULATIVE NUMBER OF DAYS FROM THE BEGINNING
      C                      OF THE YEAR TO THE END OF THE (I-1)TH MONTH, IN
      C                      A NON-LEAP YEAR.
      CCC
            DIMENSION  DAYM(12)
            DATA  (DAYM(I),I=1,12) /  0.,31.,59.,90.,120.,151.,181.,212.,
           *                          243.,273.,304.,334. /
            DAYS = IDAYS
11          YRS = IYRS
      CCC
      C          THE FIRST TERM FOR DAYJ IS THE JULIAN DAY NUMBER AT 0 HRS UT
      C          1900 JANUARY 1.  THE THIRD TERM FOR DAYJ IS THE NUMBER OF
      C          EXTRA (LEAP-YEAR) DAYS SINCE 1900 TO THE START OF THE YEAR
      C          OF INTEREST.
      CCC
12          DAYJ = 2415020.5 + 365.*YRS + AINT( (YRS-1.)/4. )
20          YREFJ = DAYJ
      C          VERNAL EQUINOX OCCURS WITHIN ABOUT 7 SECONDS OF TIME AT
      C          00 HOURS ON 21 MARCH 1974, AT WHICH TIME THE JULIAN DAY
      C          NUMBER IS 2442127.5 .  FOR NEARBY YEARS THE JULIAN DATE FOR
      C          VERNAL EQUINOX WILL BE GIVEN BY VEQJ..
20          VEQJ = 2442127.5 + 365.25*(YRS-74.)
      CCC
      C          LEAP IS AN INDEX THAT EQUALS 0  FOR A LEAP YEAR AND OTHERWISE
      C          EQUALS 1, 2, OR 3 .
      CCC
23          LEAP = MOD(IYRS,4)
25          IF( IMONS.LT.3 )  GO TO 1
30          IF(  LEAP.EQ.0  )  DAYJ = DAYJ+1.0
32        1 DAYJ = DAYJ + DAYM(IMONS) + (DAYS-1.0)
36          RETURN
37          END
```

```
      FUNCTION RATE(INDX,TEM)                                           DRIVER.1266
C                                                                       DRIVER.1267
C     REACTION RATE COEFFICIENT FOR A SPECIFIED REACTION                DRIVER.1268
C                                                                       DRIVER.1269
C         INPUTS                                                        DRIVER.1270
C     INDX = REACTION INDEX (SEE BELOW)                                 DRIVER.1271
C     TEM  = TEMPERATURE (DEG K)                                        DRIVER.1272
C            VIBRATIONAL/ELECTRON TEMPERATURE FOR REACTIONS 7,8,10-14,23DRIVER.1273
C            AND 24                                                     DRIVER.1274
C         OUTPUT                                                        DRIVER.1275
C     RATE = REACTION RATE COEFFICIENT                                  DRIVER.1276
C                                                                       DRIVER.1277
C     REACTIONS INCLUDED                                                DRIVER.1278
C                                                                       DRIVER.1279
C      1 N+ + O2 = NO+ + O                2 N+ + O2 = O2+ + N           DRIVER.1280
C      3 N+ + O2 = O+ + NO                4 N+ + N2 = N2+ + N           DRIVER.1281
C      5 N+ + NO = NO+ + N                6 N+ + O = O+ + N             DRIVER.1282
C      7 N+ + E = N + HNU                 8 N+ + E + E = N + E          DRIVER.1283
C      9 O+ + O2 = O2+ + O               10 O+ + N2 = NO+ + N           DRIVER.1284
C     11 O+ + E = O + HNU                12 O+ + E + E = O + E          DRIVER.1285
C     13 NO+ + E = N(4S) + O             14 NO+ + E = N(2D) + O         DRIVER.1286
C     15 N(4S) + O = NO+ + E             16 N(2D) + O = NO+ + E         DRIVER.1287
C     17 N + O = NO + HNU                18 N + N = N2 + HNU            DRIVER.1288
C     19 N(4S) + O2 = NO + O             20 N(2D) + O2 = NO + O         DRIVER.1289
C     21 N(4S) + NO = N2 + O             22 N(2D) + NO = N2 + O         DRIVER.1290
C     23 N(4S) + E = N(2D) + E           24 N(2D) + E = N(4S) + E       DRIVER.1291
C     25 O + N2 = NO + N                 26 E+O2+O2 = O2-+O2            DRIVER.1292
C     27 O2-+O2 = E+O2+O2                28 O2-+O = O3+E                DRIVER.1293
C     29 O3+E = O2-+O                    30 O2-+O2+M = O4-+M            DRIVER.1294
C     31 O4-+M = O2-+O2+M                32 O4-+O = O3-+O2              DRIVER.1295
C     33 O3-+O2 = O4-+O                  34 O4-+NO = OONO-+O2           DRIVER.1296
C     35 OONO-+O2 = O4-+NO               36 O3-+O = O2-+O2              DRIVER.1297
C     37 O2-+O2 = O3-+O                  38 O3-+NO = NO2-+O2            DRIVER.1298
C     39 O2+NO2- = O3-+NO                40 OONO-+NO = NO2-+NO2         DRIVER.1299
C     41 NO2-+NO2 = OONO-+NO             42 O2-+NO2 = NO2-+O2           DRIVER.1300
C     43 NO2-+O2 = O2-+NO2               44 NO2+E = NO2-+HNU            DRIVER.1301
C     45 NO2-+HNU = NO2+E                46 NO2-+NO2 = NO3-+NO          DRIVER.1302
C     47 NO3-+NO = NO2-+NO2              48 X++Y- = PRODUCTS            DRIVER.1303
C     49 X++Y-+M = PRODUCTS              50 AL++E+M = AL+M              DRIVER.1304
C     51 UO2++E = U+O2                   52 UO++E = U+O                 DRIVER.1305
C     53 UO2++E = UO+O                   54 U++E+M = U+M                DRIVER.1306
C     55 O+E = O-+HNU                    56 O-+O = O2+E                 DRIVER.1307
C     57 O-+NO = NO2+E                   58 O-+N = NO+E                 DRIVER.1308
C     59 O-+O2 = O3+E                    60 ALO2+E+M = ALO2-+M          DRIVER.1309
C     61 ALO2-+M = ALO2+E+M              62 ALO++E =AL+O                DRIVER.1310
C     63 O+NO2 = NO+O2                   64 NO+O2 = O+NO2               DRIVER.1311
C     65 O2-+NO = NO2-+O                 66 NO2-+3 = O2-+O              DRIVER.1312
C                                                                       DRIVER.1313
      COMMON/CHEMR/  AR(66),  BR(66),  CR(66)                           DRIVER.1314
C                                                                       DRIVER.1315
      TMX=TEM                                                           DRIVER.1316
      TMY=TEM/300.                                                      DRIVER.1317
      EX1=1.0                                                           DRIVER.1318
      IF(BR(INDX).NE.0.0) EX1=TMY**(BR(INDX))                           DRIVER.1319
      EX2=1.0                                                           DRIVER.1320
      IF(CR(INDX).EQ.0.0) GO TO 30                                      DRIVER.1321
```

```
RATE
      20          EXPO=-CR(INDX)/TMX
      22          IF(EXPO.GT.-70.0) GO TO 25
      26          RATE = 0.0
      26          GO TO 100
      27       25 EX2=EXP(EXPO)
      33       30 RATE=AR(INDX)*EX1*EX2
      36          IF(INDX.EQ.10) RATE = AMAX1(1.3E-12, AMIN1(1.E-10, RATE))
      47      100 RETURN
      51          END
```

```
         SUBROUTINE SOLCYC(DAYJ)                                          DRIVER,1331
    CCC                                                                   DRIVER,1332
    C           SUBROUTINE SOLCYC COMPUTES THE SOLAR FLUX SBAR, AN INPUT TO  DRIVER,1333
    C           ATMOSU THROUGH COMMON ATMOUP, BASED ON AN ASSUMED SINUSOIDAL DRIVER,1334
    C           11-YR (OR 4018-DAY) VARIATION, WITH THE MAXIMUM VALUE OF 250 DRIVER,1335
    C           FOR SBAR, ASSOCIATED WITH CIRA-65 MODEL 9, OCCURRING ON      DRIVER,1336
    C           1958 JUNE 1.  THE MINIMUM VALUE OF 65 FOR SBAR IS ASSOCIATED DRIVER,1337
    C           WITH CIRA-65 MODEL 1.                                        DRIVER,1338
    CCC                                                                   DRIVER,1339
    C       INPUT PARAMETER                                               DRIVER,1340
    C               DAYJ - JULIAN DAY NUMBER (A HALF INTEGER) AT 0 HRS UT DRIVER,1341
    C                      ON THE DAY OF INTEREST.                        DRIVER,1342
    CCC                                                                   DRIVER,1343
    C       OUTPUT PARAMETER                                              DRIVER,1344
    C               SBAR - AVERAGE 10.7-CM SOLAR FLUX, 1.0E-22 W/(M**2 HZ). DRIVER,1345
    C                      SBAR IS AN INPUT TO ATMOSU THROUGH COMMON ATMOUP. DRIVER,1346
    CCC                                                                   DRIVER,1347
         COMMON/ATMOUP/  HL,SBAR,IDURN,PP,RHO,TT,SNI(16),HRHO,FEHSEQ      DRIVER,1348
    CCC                                                                   DRIVER,1349
    C       DEFINITION OF DATA                                            DRIVER,1350
    C           DJ5806 - JULIAN DAY NUMBER ON 1958 JUNE 1 =  2436355.5    DRIVER,1351
         DATA  DJ5806 / 2436355.5 /                                       DRIVER,1352
         DATA  PI / 3.141592653590 /                                      DRIVER,1353
    CCC                                                                   DRIVER,1354
         PI2 = 2.*PI                                                      DRIVER,1355
  4      SBAR = 157.5 + 92.5*COS( (DAYJ-DJ5806)*PI2/4018. )               DRIVER,1356
 14      RETURN                                                           DRIVER,1357
 15      END                                                              DRIVER,1358
```

SOLORB

```
      SUBROUTINE SOLORB(YREJ,VEQJ,DAYJ,SOLLAT,SOLLON)
CCC
C            SUBROUTINE SOLORB COMPUTES THE NORTH LATITUDE SOLLAT AND
C            EAST LONGITUDE SOLLON OF THE APPARENT (ACTUAL MOTION)
C            SUBSOLAR POINT, GIVEN THE JULIAN DAY NUMBER AT 0 HRS UT ON
C            JANUARY 1 OF THE YEAR OF INTEREST (YREJ), THE JULIAN DATE AT
C            WHICH VERNAL EQUINOX OCCURS (VEQJ), THE JULIAN DAY NUMBER AT
C            0 HRS ON THE DAY OF INTEREST (DAYJ), AND THE UNIVERSAL
C            TIME (UT).
CCC
C     INPUT PARAMETERS
C              YREJ - JULIAN DAY NUMBER (A HALF INTEGER) AT 0 HRS UT ON
C                     JANUARY 1 OF THE YEAR OF INTEREST.
C              VEQJ - JULIAN DATE FOR VERNAL EQUINOX.
C              DAYJ - JULIAN DAY NUMBER (A HALF INTEGER) AT 0 HRS UT
C                     ON THE DAY OF INTEREST.
C                UT - UNIVERSAL TIME (DECIMAL HRS).
CCC
C     OUTPUT PARAMETERS
C               GAT - GREENWICH APPARENT TIME (DECIMAL HRS).
C                     GAT IS PLACED IN COMMON TIME.
C            SOLLAT - NORTH LATITUDE OF SUBSOLAR POINT (RADIANS).
C            SOLLON - EAST LONGITUDE OF SUBSOLAR POINT (RADIANS).
CCC
C     DEFINITIONS AND COMMENTS
C            UTD24 IS THE DECIMAL FRACTION OF DAY CORRESPONDING TO UT.
C            DAYJUT IS THE JULIAN (DECIMAL) DAY NUMBER AT UT HRS ON THE
C            DAY OF INTEREST.
C            DAYNO IS THE NUMBER OF ELAPSED (DECIMAL) DAYS SINCE THE
C            BEGINNING OF THE YEAR AT 0 HRS UT ON JANUARY 1.
C            THE QUANTITY (DAYJUT - AINT(DAYJUT)), THE WEST LONGITUDE OF
C            THE SUBSOLAR POINT EXPRESSED AS A DECIMAL FRACTION OF 2*PI
C            RADIANS, IS SUBTRACTED FROM 1 TO OBTAIN THE FRACTIONAL EAST
C            LONGITUDE.  THE FIRST TWO EXPRESSIONS FOR SOLLON ARE THE EAST
C            LONGITUDE OF THE SUBSOLAR POINT OF THE (FICTITIOUS) MEAN SUN.
C            IT IS POSSIBLE TO MAKE AN APPROXIMATE CORRECTION FOR THE
C            DIFFERENCE BETWEEN THE APPARENT (ACTUAL MOTION) SOLAR TIME
C            AND THE MEAN SOLAR TIME, KNOWN AS THE EQUATION-OF-TIME (SEE,
C            E.G., AMERICAN PRACTICAL NAVIGATOR (ORIGINALLY BY N.
C            BOWDITCH), U.S. NAVY H.O. PUB. NO. 9, P. 375, OF 1962
C            CORRECTED REPRINT EDITION, AVAILABLE FROM U.S. GOV. PRINTING
C            OFFICE).  IN THE U.S.A. (IN CONTRAST TO GREAT BRITAIN) THE
C            SIGN OF THE EQUATION-OF-TIME IS CONSIDERED POSITIVE IF THE
C            TIME OF THE MERIDIAN TRANSIT BY THE SUN IS EARLIER THAN 1200
C            HRS AND NEGATIVE IF LATER THAN 1200 HRS.  (NOTE THAT A
C            MERIDIAN TRANSIT BEFORE 1200 HRS CORRESPONDS TO THE EAST
C            LONGITUDE OF THE SUN BEING SMALLER THAN THE VALUE EXPECTED
C            BASED ON A MEAN SUN.)  ANNUAL EDITIONS OF THE NAUTICAL
C            ALMANAC PRIOR TO 1962 TABULATED VALUES OF THE EQUATION-OF-TIME
C            AT 12-HR INTERVALS.  THESE TABULATED VALUES OF THE EQUATION-OF
C            -TIME COULD BE ADDED TO THE GREENWICH MEAN TIME (OR UNIVERSAL
C            TIME) TO OBTAIN THE GREENWICH APPARENT (OR ACTUAL MOTION)
C            TIME.  NEWER ANNUAL EDITIONS OF THE AMERICAN EPHEMERIS AND
C            NAUTICAL ALMANAC OR THE ASTRONOMICAL EPHEMERIS DO NOT EVEN
C            EXPLICITLY REFER TO THE TERM EQUATION-OF-TIME.  INSTEAD, FOR
C            MERIDIAN TRANSITS AND OTHER PHENOMENA THAT DEPEND ON HOUR
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C         ANGLES AND GEOGRAPHIC LOCATION, THE NEWER EDITIONS REFER NOT   DRIVER,1415
C         TO THE GREENWICH MERIDIAN AND TO UNIVERSAL TIME BUT TO A       DRIVER,1416
C         MERIDIAN 1.002738*(DELTA T) EAST OF THE GEOGRAPHIC MERIDIAN    DRIVER,1417
C         OF GREENWICH (KNOWN AS THE EPHEMERIS MERIDIAN) AND TO          DRIVER,1418
C         EPHEMERIS TIME.  THE SOLAR EPHEMERIS TRANSIT, WHICH IS THE     DRIVER,1419
C         EPHEMERIS TIME AT THE INSTANT OF SOLAR TRANSIT ACROSS THE      DRIVER,1420
C         EPHEMERIS MERIDIAN, IS TABULATED AT 1-DAY INTERVALS IN THE     DRIVER,1421
C         NEWER EDITIONS.  WE HAVE ADOPTED THE DEPARTURE OF THE VALUE OFDRIVER,1422
C         THE SOLAR EPHEMERIS TRANSIT FROM 12 HR 00 MIN 00 SEC AS A      DRIVER,1423
C         CONVENIENT APPROXIMATION TO THE NEGATIVE VALUE OF THE          DRIVER,1424
C         EQUATION-OF-TIME.  IN PARTICULAR, WE HAVE USED VALUES OF THE   DRIVER,1425
C         SOLAR EPHEMERIS TRANSIT FOR 1974 TABULATED IN THE 1974 EDITIONDRIVER,1426
C         OF EITHER THE ASTRONOMICAL EPHEMERIS OR THE AMERICAN EPHEMERISDRIVER,1427
C         AND NAUTICAL ALMANAC, AND FITTED OUR ADOPTED VALUES OF THE     DRIVER,1428
C         EQUATION-OF-TIME BY A FOUR-TERM FOURIER SERIES.  WE IGNORE THEDRIVER,1429
C         WEAK DEPENDENCE OF THE EQUATION-OF-TIME ON THE YEAR OF         DRIVER,1430
C         INTEREST.  LOWEN'S FITTED EXPRESSION FOR THE EQUATION-OF-TIME  DRIVER,1431
C         IS GIVEN BY                                                    DRIVER,1432
C                                                                        DRIVER,1433
C         EQT = 0.385175*COS(F) - 3.146125*COS(F2)                       DRIVER,1434
C             - 7.392635*SIN(F) - 9.536825*SIN(F2) ,  MIN                DRIVER,1435
C                                                                        DRIVER,1436
C         WHERE                                                          DRIVER,1437
C                 F = RADDAY*(DAYJ-YRFJ)                                 DRIVER,1438
C                F2 = 2.*F                                               DRIVER,1439
C            RADDAY = 2.*PI/365.25 RADIANS PER DAY                       DRIVER,1440
C                   = 0.0172024238 .                                     DRIVER,1441
C         TO CONVERT FROM MINUTES OF TIME TO RADIANS OF LONGITUDE WE     DRIVER,1442
C         MUST MULTIPLY EQT BY                                           DRIVER,1443
C            RADMIN = 2.*PI/1440 RADIANS PER MINUTE                      DRIVER,1444
C                   = 0.00436332313 .                                    DRIVER,1445
C         THUS, THE EAST LONGITUDE (RADIANS) OF THE APPARENT SUN IS      DRIVER,1446
C            SOLLON = SOLLON-RADMIN*EQT                                  DRIVER,1447
C         THE NORTH LATITUDE (RADIANS) OF THE APPARENT SUN IS            DRIVER,1448
C            SOLLAT = SLATMX*SIN( (DAYJUT-VEQJ)*RADDAY )                 DRIVER,1449
C         WHERE THE MAXIMUM VALUE OF THE SOLAR LATITUDE IS               DRIVER,1450
C            SLATMX = 0.409123 RADIANS .                                 DRIVER,1451
CCC                                                                      DRIVER,1452
      COMMON/TIME/  IYRS,IMONS,IDAYS,ZT,PLAT,PLON,UT,GAT                 DRIVER,1453
CCC                                                                      DRIVER,1454
C     DEFINITIONS OF DATA AND CONSTANTS                                  DRIVER,1455
C                PI = 3.141592653590                                     DRIVER,1456
C               PI2 = 2.*PI                                              DRIVER,1457
C            RADDAY = PI2/365.25 RADIANS PER DAY IN A JULIAN YEAR        DRIVER,1458
C                   = 0.0172024238                                       DRIVER,1459
C            RADMIN = PI2/1440 RADIANS PER MINUTE IN A DAY               DRIVER,1460
C                   = 0.00436332313                                      DRIVER,1461
C            SLATMX = MAXIMUM VALUE OF SOLAR LATITUDE                    DRIVER,1462
C                   = 0.409123 RADIANS                                   DRIVER,1463
CCC                                                                      DRIVER,1464
      DATA  PI,SLATMX / 3.141592653590, 0.409123 /                       DRIVER,1465
CCC                                                                      DRIVER,1466
      PI2 = 2.*PI                                                        DRIVER,1467
      RADDAY = PI2/365.25                                                DRIVER,1468
      RADMIN = PI2/1440.                                                 DRIVER,1469
      UTD24 = UT/24.                                                     DRIVER,1470
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15          DAYJUT = DAYJ + UTD24                                    DRIVER.1471
16          DAYNO = DAYJUT - YREFJ                                   DRIVER.1472
20          SOLLON = PI2*(1.0-DAYJUT+AINT( DAYJUT ))                 DRIVER.1473
24          IF( SOLLON.LT.0.0 )  SOLLON = SOLLON+PI2                 DRIVER.1474
27          F = RADDAY*DAYNO                                         DRIVER.1475
31          F2 = 2.*F                                                DRIVER.1476
33          EQT = 0.385175*COS(F) - 3.146125*COS(F2)                 DRIVER.1477
         *        - 7.392635*SIN(F) - 9.536825*SIN(F2)               DRIVER.1478
54          GAT = UT + EQT/60.                                       DRIVER.1479
57          SOLLON = SOLLON - RADMIN*EQT                             DRIVER.1480
61          SOLLAT = SLATMX*SIN( (DAYJUT-VEQJ)*RADDAY )              DRIVER.1481
72          RETURN                                                   DRIVER.1482
72          END                                                      DRIVER.1483
```

SOLVE

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           SUBROUTINE SOLVE (A, X, NO)                                          DRIVER,1484
      CCC                                                                       DRIVER,1485
      C         SUBROUTINE SOLVE, CALLED FROM SUBROUTINE FITTER, SOLVES A SET   DRIVER,1486
      C         OF NO SIMULTANEOUS LINEAR ALGEBRAIC EQUATIONS BY USING          DRIVER,1487
      C         GAUSS-JORDAN METHOD WITH MAXIMUM PIVOT FEATURE. (SEE, FORTRAN   DRIVER,1488
      C        IV PROGRAMMING AND COMPUTING BY JAMES T. GOLDEN, PRENTICE-HALL,  DRIVER,1489
      C         INC., PAGES 88-99) 1965                                         DRIVER,1490
      CCC                                                                       DRIVER,1491
      C     INPUT PARAMETERS                                                    DRIVER,1492
      C            A(I,J) - MATRIX OF CONSTANT COEFFICIENTS IN SET CONTAINING   DRIVER,1493
      C                     THE NUMBER NO SIMULTANEOUS LINEAR ALGEBRAIC         DRIVER,1494
      C                     EQUATIONS                                           DRIVER,1495
      C                NO - THE NUMBER OF EQUATIONS                             DRIVER,1496
      CCC                                                                       DRIVER,1497
      C     OUTPUT PARAMETERS                                                   DRIVER,1498
      C              X(K) - THE LEAST-SQUARES FIT COEFFICIENTS                  DRIVER,1499
      CCC                                                                       DRIVER,1500
           DIMENSION  A(20,21), B(20,21), X(20), LOC(20), ROW(20)               DRIVER,1501
           KNO = NO+1                                                           DRIVER,1502
   6       DO 150 I=1,NO                                                        DRIVER,1503
  10       DO 150 J=1,KNO                                                       DRIVER,1504
  17       B(I,J) = A(I,J)                                                      DRIVER,1505
  20   150 CONTINUE                                                             DRIVER,1506
  26       DO 10 M=1,NO                                                         DRIVER,1507
  33       LOC(M) = 0                                                           DRIVER,1508
  34    10 ROW(M) = 0.0                                                         DRIVER,1509
  35       NP = NO+1                                                            DRIVER,1510
  41       DO 100 I=1,NO                                                        DRIVER,1511
  42       IP = I+1                                                             DRIVER,1512
      C-----FIND MAX ELEMENT IN I-TH COL.                                       DRIVER,1513
  43       AMAX = 0.0                                                           DRIVER,1514
  44       DO 2 K=1,NO                                                          DRIVER,1515
  46       IF(AMAX - ABS( A(K,I))) 3,2,2                                        DRIVER,1516
      C-----IS NEW MAX IN ROW PREVIOUSLY USED AS PIVOT.                         DRIVER,1517
  54     3 IF(ROW(K)) 4,4,2                                                     DRIVER,1518
  62     4 LOC(I) = K                                                           DRIVER,1519
  63       AMAX = ABS( A(K,I))                                                  DRIVER,1520
  64     2 CONTINUE                                                             DRIVER,1521
  67       IF(AMAX) 99,99,98                                                    DRIVER,1522
      C-----MAX ELEMENT IN I-TH COL IS A(L,I)                                   DRIVER,1523
  70    98 L = LOC(I)                                                           DRIVER,1524
  72       ROW(L) = 1.0                                                         DRIVER,1525
      C-----PERFORM ELIMINATION, L IS PIVOT ROW, A(L,I) IS PIVOT ELEMENT.       DRIVER,1526
  74       DO 50 J=1,NO                                                         DRIVER,1527
  75       IF(L-J) 6,50,6                                                       DRIVER,1528
  76     6 QF = -A(J,I)/A(L,I)                                                  DRIVER,1529
 104       DO 40 K=IP,NP                                                        DRIVER,1530
 115       A(J,K) = A(J,K)+QF*A(L,K)                                            DRIVER,1531
 117    40 CONTINUE                                                             DRIVER,1532
 122    50 CONTINUE                                                             DRIVER,1533
 125   100 CONTINUE                                                             DRIVER,1534
 127       DO 200 I=1,NO                                                        DRIVER,1535
 137       L = LOC(I)                                                           DRIVER,1536
 140   200 X(I) = A(L,NO+1)/A(L,I)                                              DRIVER,1537
      C    WRITE(6,103)  (J, X(J),J=1,NO)                                       DRIVER,1538
      C 103 FORMAT (4(I8,2X,E15.8))                                             DRIVER,1539
 146       RETURN                                                               DRIVER,1540
 146    99 WRITE(6,104)                                                         DRIVER,1541
       104 FORMAT (5X,27H NO UNIQUE SOLUTION EXISTS.)                           DRIVER,1542
 154       RETURN                                                               DRIVER,1543
 155       END                                                                  DRIVER,1544
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SOLZEN

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      SUBROUTINE SOLZEN(SOLLAT,SOLLON)                                  DRIVER,1545
CCC                                                                     DRIVER,1546
C          SUBROUTINE SOLZEN COMPUTES COSCHI, THE COSINE OF THE ZENITH  DRIVER,1547
C          ANGLE OF THE SUN AT A POINT P, GIVEN THE GEOGRAPHIC NORTH    DRIVER,1548
C          LATITUDE PLAT AND EAST LONGITUDE PLON OF THE POINT P AND THE DRIVER,1549
C          NORTH LATITUDE SOLLAT AND EAST LONGITUDE SOLLON OF THE       DRIVER,1550
C          SUBSOLAR POINT.  THE DAY-OR-NIGHT PARAMETER IDORN IS 1 FOR   DRIVER,1551
C          DAYTIME, I.E., IF(COSCHI.GE.0.0),  AND IS -1 FOR NIGHTTIME,  DRIVER,1552
C          I.E., IF(COSCHI.LT.0.0).  THE LOCAL APPARENT TIME HL         DRIVER,1553
C          IS ALSO COMPUTED FROM THE GREENWICH APPARENT TIME GAT AND THE DRIVER,1554
C          LONGITUDE PLON.                                              DRIVER,1555
CCC                                                                     DRIVER,1556
C     INPUT PARAMETERS                                                  DRIVER,1557
C                PLAT - NORTH LATITUDE OF POINT P (RADIANS)             DRIVER,1558
C                PLON - EAST LONGITUDE OF POINT P (RADIANS)             DRIVER,1559
C              SOLLAT - NORTH LATITUDE OF SUBSOLAR POINT (RADIANS)      DRIVER,1560
C              SOLLON - EAST LONGITUDE OF SUBSOLAR POINT (RADIANS)      DRIVER,1561
CCC                                                                     DRIVER,1562
C     OUTPUT PARAMETERS                                                 DRIVER,1563
C               IDORN - PARAMETER FOR DAY OR NIGHT.  IF COSCHI IS       DRIVER,1564
C                       THE COSINE OF THE ZENITH ANGLE OF THE SUN AT    DRIVER,1565
C                       POINT P, IDORN IS 1 FOR DAYTIME, I.E.,          DRIVER,1566
C                       IF(COSCHI.GE.0.0), AND IS -1 FOR NIGHTTIME,     DRIVER,1567
C                       I.E., IF(COSCHI.LT.0.0) , IDORN IS AN INPUT TO  DRIVER,1568
C                       ATMOSU THROUGH COMMON ATMOUP.                   DRIVER,1569
C                  HL - LOCAL APPARENT TIME (DECIMAL HRS, E.G. 2230 HRS DRIVER,1570
C                       BECOMES 22.50 HRS).  HL IS AN INPUT TO ATMOSU   DRIVER,1571
C                       THROUGH COMMON ATMOUP.                          DRIVER,1572
CCC                                                                     DRIVER,1573
      COMMON/ATMOUP/  HL,SHAF,IDORN,PP,RHO,TT,SNI(16),HRHO,FEHSFQ       DRIVER,1574
      COMMON/TIME/  IYRS,IMONS,IDAYS,ZI,PLAT,PLON,UT,GAT                DRIVER,1575
      DATA  PI / 3.14159265359 /                                        DRIVER,1576
CCC                                                                     DRIVER,1577
C          THE FOLLOWING FORMULA IS BASED ON EQ. (1.41) OF IONOSPHERIC  DRIVER,1578
C          RADIO PROPAGATION BY K. DAVIES, NBS MONOGRAPH 80, 1965       DRIVER,1579
C          APRIL 1.  IT MAY ALSO BE DERIVED BY APPLYING THE LAW OF      DRIVER,1580
C          COSINES FOR AN OBLIQUE SPHERICAL TRIANGLE.                   DRIVER,1581
CCC                                                                     DRIVER,1582
      COSCHI = SIN(PLAT) * SIN(SOLLAT)                                  DRIVER,1583
     *       + COS(PLAT) * COS(SOLLAT) * COS(PLON-SOLLON)               DRIVER,1584
27    IDORN = 1                                                         DRIVER,1585
30    IF( COSCHI.LT.0.0 )  IDORN = -IDORN                               DRIVER,1586
34    PI2 = 2.*PI                                                       DRIVER,1587
36    RADHR = PI/12.                                                    DRIVER,1588
37    HL = GAT - (PI2-PLON)/RADHR                                       DRIVER,1589
42    IF( HL.LT.0.0 )  HL = HL+24.                                      DRIVER,1590
46    RETURN                                                            DRIVER,1591
47    END                                                               DRIVER,1592
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      SUBROUTINE SPCMIN(KK,ZH)                                          DRIVER,1593
CCC                                                                     DRIVER,1594
C         THE HIGH-ALTITUDE CHEMISTRY MODULE REQUIRES THE MINOR NEUTRAL DRIVER,1595
C         SPECIES O, CO2, N, AND NO.  PROFILES FOR DAY AND NIGHT AT ALL DRIVER,1596
C         ALTITUDES ARE PROVIDED FOR O AND CO2 IN ATMOSU.  HERE IN      DRIVER,1597
C         SPCMIN WE PROVIDE PROFILES OF N AND NO.                       DRIVER,1598
C         THE LOW-ALTITUDE CHEMISTRY MODULE REQUIRES, IN ADDITION TO O, DRIVER,1599
C         CO2, N, AND NO, THE MINOR NEUTRAL SPECIES H2O, O2(SINGLET     DRIVER,1600
C         DELTA G), O3, AND NO2, ALSO PROVIDED BY SPCMIN.               DRIVER,1601
C     INPUT PARAMETERS                                                  DRIVER,1602
C         ARGUMENT LIST                                                 DRIVER,1603
C                KK - CALCULATION FLAG                                  DRIVER,1604
C                   = 1, CALCULATE INITIALIZATION PARAMETERS            DRIVER,1605
C                   = 2, CALCULATE ATMOSPHERIC PROPERTIES               DRIVER,1606
C                ZH - ALTITUDE OF INTEREST (KM)                         DRIVER,1607
C         ATMOUP COMMON                                                 DRIVER,1608
C             IDORN - INDEX FOR DAY OR NIGHT                            DRIVER,1609
C                   = +1, DAY                                           DRIVER,1610
C                   = -1, NIGHT                                         DRIVER,1611
C         ALTODN COMMON                                                 DRIVER,1612
C              SIZ2N                                                    DRIVER,1613
C     OUTPUT PARAMETERS                                                 DRIVER,1614
C         ATMOUP COMMON                                                 DRIVER,1615
C           SNI( 7) - N         DENSITY,  1/CM**3                       DRIVER,1616
C           SNI( 8) - NO        DENSITY,  1/CM**3                       DRIVER,1617
C           SNI(13) - O2(SDG) DENSITY,  1/CM**3                         DRIVER,1618
C           SNI(14) - O3        DENSITY,  1/CM**3                       DRIVER,1619
C           SNI(15) - NO2       DENSITY,  1/CM**3                       DRIVER,1620
C           SNI(16) - H2O       DENSITY,  1/CM**3                       DRIVER,1621
C         ALTODN COMMON                                                 DRIVER,1622
C            NALTOD - NUMBER OF ALTITUDES AT WHICH THE DAYTIME          DRIVER,1623
C                     O-VALUES ARE SPECIFIED AS DATA                    DRIVER,1624
C         ALTKM(47) - THE ALTITUDES AT WHICH MINOR SPECIES ARE          DRIVER,1625
C                     SPECIFIED AS DATA                                 DRIVER,1626
C          ODAY(27) - THE DAYTIME O-VALUES SPECIFIED AS DATA            DRIVER,1627
C         ONITE(18) - THE NIGHTTIME O-VALUES SPECIFIED AS DATA          DRIVER,1628
C           CO2(25) - THE CO2-VALUES SPECIFIED AS DATA                  DRIVER,1629
CCC                                                                     DRIVER,1630
      DIMENSION  AA(13),BB(13),CC(13),ANONIT(18),ANDAY(47),ANNITE(47)   DRIVER,1631
      DIMENSION  O2SDGD(47),O2SDGN(47),O3DAY(27),O3NIT(27),DD(11)       DRIVER,1632
      DIMENSION  Y(6),Z(6),FE(10),UO3(6),VO3(6),WO3(6)                  DRIVER,1633
      DIMENSION  H2ODN(25),GG(13),ANODAY(45)                            DRIVER,1634
      DIMENSION A(20,21),X(9),ZINON(8),ANONZI(8),ZIM2NO(8)              DRIVER,1635
      DIMENSION  SNO2D(33),SNO2N(33),HH(13)                             DRIVER,1636
      COMMON/ATMOUP/  HL,SBAR,IDORN,PP,RHO,TT,SNI(16),HRHO,FEHSEQ       DRIVER,1637
      COMMON/ALTODN/  NALTOD,ALTKM(47),ODAY(27),ONITE(18),SIZ2N,CO2(25) DRIVER,1638
      COMMON/ZHCHEX/  ZHFLAG                                            DRIVER,1639
CCC                                                                     DRIVER,1640
      DATA  NDEGNO / 12 /, NDEGND,NDEGNN / 8, 6 /                       DRIVER,1641
      DATA  NALTOD,NALTNO / 27,25 /, NALTND,NALTNN / 39,30 /            DRIVER,1642
      DATA  NDGO2D,NALTO2 / 10,11 /                                     DRIVER,1643
      DATA  NDGH2O,NKMH2O / 12,25 /                                     DRIVER,1644
      DATA  NDGNO2,NKMNO2 / 12,33 /                                     DRIVER,1645
      DATA  (ALTKM(I),I=1,47) /  0.,5.,10.,15.,20.,25.,30.,35.,40.,45., DRIVER,1646
     *                          50.,55.,60.,65.,70.,75.,80.,85.,90.,95.,DRIVER,1647
     *  100.,105.,110.,115.,120.,125.,130.,135.,140.,145.,150.,155.,    DRIVER,1648
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     * 160.,165.,170.,175.,180.,185.,190.,195.,200.,205.,210.,215.,     DRIVER.1649
     * 220.,225.,230. /                                                 DRIVER.1650
C        BFM VALUES  11/09/74     FOR  O    DAY                         DRIVER.1651
      DATA  (ODAY(I),I=1,27) /  1.0E+03,6.2E+03,2.2E+04,1.9E+05,1.0E+06,DRIVER.1652
     *                          7.0E+06,4.5E+07,2.6E+08,9.8E+08,2.9E+09,DRIVER.1653
     * 6.7E+09,1.3E+10,2.4E+10,3.1E+10,2.8E+10,4.5E+10,7.1E+10,1.1E+11,DRIVER.1654
     * 1.7E+11,4.6E+11,4.3E+11,3.3E+11,2.0E+11,1.3E+11,6.3E+10,4.4E+10,DRIVER.1655
     * 3.7E+10 /                                                        DRIVER.1656
C        BFM VALUES  02/22/75     FOR O    NIGHT                        DRIVER.1657
      DATA  (ONITE(I),I=1,18) /  13*1.1, 2*0.0, 4.90E+08,               DRIVER.1658
     *                          3.00E+10, 9.00E+10 /                    DRIVER.1659
C        BFM VALUES  12/07/74     FOR CO2                               DRIVER.1660
      DATA  (CO2(I),I=1,25) / 21*0.0, 1.30E+09,4.80E+08,1.70E+08,       DRIVER.1661
     *                                 5.65E+07 /                       DRIVER.1662
C        THE CO2 VALUES AT ALTITUDES FROM 0.0 TO 100. KM ARE RESET      DRIVER.1663
C        IN SUBROUTINE ATMOSU BY USING A CONSTANT MIXING-RATIO OF       DRIVER.1664
C        3.20E-04                                                       DRIVER.1665
C        BFM VALUES  04/05/75     FOR  NO  DAY                          DRIVER.1666
      DATA  (ANODAY(I),I=1,25) / 1.00E+10,3.40E+09,1.30E+09,5.80E+08,   DRIVER.1667
     *                          7.00E+08,1.75E+09,2.10E+09,1.75E+09,    DRIVER.1668
     * 1.25E+09,8.50E+08,5.10E+08,3.00E+08,1.40E+08,5.50E+07,3.70E+07,  DRIVER.1669
     * 3.30E+07,3.50E+07,4.00E+07,4.80E+07,5.80E+07,6.30E+07,5.70E+07,  DRIVER.1670
     * 4.40E+07,3.60E+07,3.00E+07 /                                     DRIVER.1671
C        BFM VALUES  04/05/75     FOR  NO  NIGHT                        DRIVER.1672
      DATA  (ANONIT(I),I=1,18) /  11*1.00E+00,1.00E+04,1.00E+06,        DRIVER.1673
     *                          8.30E+06,1.65E+07,2.50E+07,3.30E+07,    DRIVER.1674
     * 4.00E+07 /                                                       DRIVER.1675
C        BFM VALUES  04/12/75     FOR  N    DAY                         DRIVER.1676
      DATA  (ANDAY(I),I=1,47) / 9*1.00E+00,1.00E+01,1.00E+02,5.00E+02,  DRIVER.1677
     * 1.80E+03,7.40E+03,2.10E+04,5.20E+04,1.10E+05,2.20E+05,3.70E+05,  DRIVER.1678
     * 6.40E+05,1.00E+06,1.30E+06,2.00E+06,2.70E+06,3.40E+06,4.30E+06,  DRIVER.1679
     * 5.00E+06,5.90E+06,6.50E+06,7.00E+06,7.50E+06,7.90E+06,8.10E+06,  DRIVER.1680
     * 8.30E+06,8.40E+06,8.50E+06,8.50E+06,8.40E+06,8.30E+06,8.20E+06,  DRIVER.1681
     * 8.10E+06,8.00E+06,7.80E+06,7.50E+06,7.30E+06,7.10E+06,6.80E+06 / DRIVER.1682
C        BFM VALUES  04/12/75     FOR  N    NIGHT                       DRIVER.1683
      DATA  (ANNITE(I),I=1,47)/18*1.00E+00,1.20E+01,1.20E+02,7.00E+02,  DRIVER.1684
     * 3.10E+03,1.10E+04,3.00E+04,7.30E+04,1.60E+05,3.00E+05,4.00E+05,  DRIVER.1685
     * 4.80E+05,5.60E+05,6.30E+05,6.80E+05,7.20E+05,7.50E+05,7.80E+05,  DRIVER.1686
     * 7.90E+05,7.90E+05,7.80E+05,7.70E+05,7.50E+05,7.20E+05,6.90E+05,  DRIVER.1687
     * 6.60E+05,6.30E+05,6.00E+05,5.60E+05,5.10E+05 /                   DRIVER.1688
C        BFM VALUES  01/04/75     FOR  O2(SDG)  DAY                     DRIVER.1689
      DATA  (O2SDGD(I),I=1,47) / 2.60E+06,4.40E+06,2.70E+07,1.25E+08,   DRIVER.1690
     *                          4.90E+08,1.25E+09,2.70E+09,9.00E+09,    DRIVER.1691
     * 1.80E+10,2.70E+10,3.50E+10,2.10E+10,1.50E+10,1.00E+10,6.10E+09,  DRIVER.1692
     * 3.10E+09,2.05E+09,3.60E+09,1.30E+09,3.00E+08,5.60E+07,4.30E+06,  DRIVER.1693
     * 6.20E+05,1.00E+05,1.40E+04,3.30E+03,7.10E+02,2.60E+02,1.00E+02,  DRIVER.1694
     * 4.70E+01,2.30E+01,1.20E+01,15*6.10 /                             DRIVER.1695
C        BFM VALUES  01/04/75     FOR  O2(SDG)  NIGHT                   DRIVER.1696
      DATA  (O2SDGN(I),I=1,47) / 15*3.40,5.80E+02,1.00E+05,8.60E+07,    DRIVER.1697
     *                          2.00E+08,1.40E+08,5.60E+07,4.30E+06,    DRIVER.1698
     * 6.20E+05,1.00E+05,1.40E+04,3.30E+03,7.10E+02,2.60E+02,1.00E+02,  DRIVER.1699
     * 4.70E+01,2.30E+01,1.20E+01,15*6.10 /                             DRIVER.1700
C        BFM VALUES  01/18/75     FOR  O3        DAY                    DRIVER.1701
      DATA  (O3DAY(I),I=1,27) /  8.0E+11,5.7E+11,1.1E+12,2.5E+12,       DRIVER.1702
     *                           4.8E+12,4.3E+12,2.5E+12,1.4E+12,       DRIVER.1703
     *   6.1E+11,2.0E+11,6.7E+10,2.0E+10,7.4E+09,2.1E+09,5.5E+08,       DRIVER.1704
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     *    1.3E+08,6.8E+07,1.2E+08,3.0E+07,2.4E+06,2.5E+05,3.4E+04,
     *    3.7E+03,3.8E+02,4.2E+01,7.3E+00,0.0 /
C         BEM VALUES  01/18/75     FOR  O3          NIGHT
      DATA  (O3NIT(I),I=1,27) /  8.0E+11,5.7E+11,1.1E+12,2.5E+12,
     *                           4.8E+12,4.3E+12,2.5E+12,1.4E+12,
     *    6.1E+11,2.0E+11,6.7E+10,2.0E+10,1.3E+10,1.2E+10,4.5E+09,
     *    7.7E+08,6.1E+07,5.8E+08,1.7E+08,2.7E+07,2.7E+06,2.9E+05,
     *    4.0E+04,3.5E+03,1.9E+02,2.4E+01,2.8E+00 /
C         BEM VALUES  05/10/75     FOR  H2O
      DATA  (H2ODN(I),I=1,25) /  1.9E+17,2.1E+16,6.0E+14,1.2E+13,
     *                           5.2E+12,3.2E+12,1.2E+12,6.2E+11,
     *    4.3E+11,2.1E+11,8.4E+10,3.6E+10,1.7E+10,9.2E+09,4.4E+09,
     *    1.8E+09,6.5E+08,2.0E+08,4.9E+07,8.4E+06,1.1E+06,1.3E+05,
     *    2.5E+04,8.7E+03,3.3E+03 /
C         BEM VALUES  02/14/75     FOR  NO2  DAY
      DATA  (SNO2D(I),I=1,33) /  2.50E+10,8.30E+09,1.40E+09,1.40E+09,
     *                           1.80E+09,2.40E+09,2.50E+09,1.25E+09,
     * 3.40E+08,7.10E+07,7.80E+06,2.30E+06,7.00E+05,2.60E+05,1.00E+05,
     * 5.00E+04,2.40E+04,1.20E+04,6.40E+03,3.40E+03,1.80E+03,1.10E+03,
     * 6.70E+02,4.30E+02,2.80E+02,1.90E+02,1.40E+02,1.15E+02,9.50E+01,
     * 8.00E+01,7.00E+01,6.00E+01,4.60E+01 /
C         BEM VALUES  02/14/75     FOR  NO2  NIGHT
      DATA  (SNO2N(I),I=1,33) /  3.50E+10,1.20E+10,2.70E+09,2.00E+09,
     *                           2.50E+09,4.15E+09,4.55E+09,3.00E+09,
     * 1.60E+09,9.20E+08,5.20E+08,3.00E+08,1.40E+08,5.50E+07,1.20E+07,
     * 1.00E+06,3.00E+04,1.20E+04,6.40E+03,3.40E+03,1.80E+03,1.10E+03,
     * 6.70E+02,4.30E+02,2.80E+02,1.90E+02,1.40E+02,1.15E+02,9.50E+01,
     * 8.00E+01,7.00E+01,6.00E+01,4.60E+01 /
CCC
C * * * ARITHMETIC STATEMENT FUNCTION USED TO CALCULATE NITRIC OXIDE IN
C * * * DAYTIME FOR ALTITUDES BELOW 120. KM.
CCC
      ANODAF( BQ ) = EXP((((((((((((( AA(13)*BQ + AA(12))*BQ + AA(11))*BQ
     *               + AA(10))*BQ + AA(9))*BQ + AA(8))*BQ + AA(7))*BQ
     *               + AA(6))*BQ + AA(5))*BQ + AA(4))*BQ + AA(3))*BQ
     *               + AA(2))*BQ + AA(1))
CCC
C * * * ARITHMETIC STATEMENT FUNCTION USED TO CALCULATE ATOMIC NITROGEN
C * * * IN DAYTIME FOR ALTITUDES ABOVE 40. AND BELOW 230. KM.
CCC
      ANDAF( BQ )  = EXP(((((((( BB(9)*BQ + BB(8))*BQ + BB(7))*BQ
     *              + BB(6))*BQ + BB(5))*BQ + BB(4))*BQ + BB(3))*BQ
     *              + BB(2))*BQ + BB(1))
CCC
C * * * ARITHMETIC STATEMENT FUNCTION USED TO CALCULATE ATOMIC NITROGEN
C * * * AT NIGHTTIME FOR ALTITUDES FROM 85. KM TO 230. KM.
CCC
      ANNAF( BQ ) = EXP(((((( CC(7)*BQ
     *               + CC(6))*BQ + CC(5))*BQ + CC(4))*BQ + CC(3))*BQ
     *               + CC(2))*BQ + CC(1))
CCC
C * * * ARITHMETIC STATEMENT FUNCTION USED TO CALCULATE O2(1 DELTA)
C * * * IN DAYTIME FOR ALTITUDES BELOW 50.  KM.
CCC
      AO2SDF( BQ ) = EXP(((((((((( DD(11)*BQ + DD(10))*BQ + DD(9))*BQ
     *               + DD(8))*BQ + DD(7))*BQ + DD(6))*BQ + DD(5))*BQ
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     *                + DD(4))*BQ + DD(3))*BQ + DD(2))*BQ + DD(1))           DRIVER,1761
      CCC                                                                    DRIVER,1762
      C * * * ARITHMETIC STATEMENT FUNCTION USED TO CALCULATE WATER FOR      DRIVER,1763
      C * * * DAYTIME OR NIGHTTIME FOR ALTITUDES BELOW 120. KM               DRIVER,1764
      CCC                                                                    DRIVER,1765
            AH2OFF( BQ ) = EXP((((((((((((( GG(13)*BQ + GG(12))*BQ + GG(11))*BQDRIVER,1766
     *                + GG(10))*BQ + GG(9))*BQ + GG(8))*BQ + GG(7))*BQ       DRIVER,1767
     *                + GG(6))*BQ + GG(5))*BQ + GG(4))*BQ + GG(3))*BQ        DRIVER,1768
     *                + GG(2))*BQ + GG(1))                                   DRIVER,1769
      CCC                                                                    DRIVER,1770
      C * * * ARITHMETIC STATEMENT FUNCTION USED TO CALCULATE NO2 FOR        DRIVER,1771
      C * * * DAYTIME AT ALTITUDES BELOW 160. KM.                            DRIVER,1772
      CCC                                                                    DRIVER,1773
            ANO2FF( BQ ) = EXP((((((((((((( HH(13)*BQ + HH(12))*BQ + HH(11))*BQDRIVER,1774
     *                + HH(10))*BQ + HH(9))*BQ + HH(8))*BQ + HH(7))*BQ       DRIVER,1775
     *                + HH(6))*BQ + HH(5))*BQ + HH(4))*BQ + HH(3))*BQ        DRIVER,1776
     *                + HH(2))*BQ + HH(1))                                   DRIVER,1777
      CCC                                                                    DRIVER,1778
            GO TO (100,200), KK                                              DRIVER,1779
      C       INITIALIZATION, CALLED FROM SUBROUTINE ATMOSU DURING ITS       DRIVER,1780
      C       INITIALIZATION.                                                DRIVER,1781
232     100 CONTINUE                                                         DRIVER,1782
232         ALOGTE = ALOG10( EXP(1.0) )                                      DRIVER,1783
      C           ATOMIC NITROGEN PROFILE PARAMETERS.                        DRIVER,1784
236         IF( IDURN )  105,110,110                                         DRIVER,1785
      C           NIGHTTIME N                                                DRIVER,1786
242     105 Z1NN = ALTKM(18)                                                 DRIVER,1787
243         Z2NN = ALTKM(47)                                                 DRIVER,1788
245         CALL FITTER(NALTNN,ALTKM(18),ANNITE(18),NDEGNN, 1 , 2 , CC)      DRIVER,1789
254         ANNZ1 = ANNAF( Z1NN )                                            DRIVER,1790
257         ANNZ2 = ANNAF( Z2NN )                                            DRIVER,1791
263         GO TO 115                                                        DRIVER,1792
      C           DAYTIME N                                                  DRIVER,1793
263     110 Z1ND = ALTKM(9)                                                  DRIVER,1794
264         Z2ND = ALTKM(47)                                                 DRIVER,1795
266         CALL FITTER(NALTND,ALTKM(9),ANDAY(9),NDEGND, 1 , 2 , BB)         DRIVER,1796
275         ANDZ1 = ANDAF( Z1ND )                                            DRIVER,1797
300         ANDZ2 = ANDAF( Z2ND )                                            DRIVER,1798
304     115 CONTINUE                                                         DRIVER,1799
      C           NITRIC OXIDE PROFILE PARAMETERS.                           DRIVER,1800
      C           FOR DAYTIME NO,.                                           DRIVER,1801
      C           IF(ZH.LT.Z7NO), WHERE Z7NO = 120 KM, NO = SNI(8) = ANODAF(ZH) DRIVER,1802
      C           WHERE THE POLYNOMIAL COEFFICIENTS AA(I) IN THE ARITHMETIC  DRIVER,1803
      C           FUNCTION ANODAF(ZH) ARE DETERMINED BY SUBROUTINE FITTER.   DRIVER,1804
304         CALL FITTER(NALTNO,ALTKM,ANODAY,NDEGNO, 1 , 2 , AA)              DRIVER,1805
      C           SET ALTITUDE VARIABLES AT 115, 120, AND 125 KM.            DRIVER,1806
313         Z6NO = ALTKM(24)                                                 DRIVER,1807
314         Z7NO = ALTKM(25)                                                 DRIVER,1808
316         Z8NO = ALTKM(26)                                                 DRIVER,1809
      C           COMPUTE FIT-FUNCTION VALUES OF NO AT ALTITUDES Z6NO=115 KM DRIVER,1810
      C           AND Z7NO=120 KM.                                           DRIVER,1811
320         ANOZ6 = ANODAF(Z6NO)                                             DRIVER,1812
323         ANOZ7 = ANODAF(Z7NO)                                             DRIVER,1813
      C           APPROXIMATE DERIVATIVE OF ALOG(NO) AT ALTITUDE Z7NO=120 KM. DRIVER,1814
      C           DLNOZ7Z, BY USING THE FIT-FUNCTION VALUES AT ALTITUDES Z6NO= DRIVER,1815
      C           115 KM AND Z7NO=120 KM.                                    DRIVER,1816
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326          DLN07Z = ALOG(AN077/ANOZ6)/(Z7N0-Z6N0)                          DRIVER,1817
      C           SET THE CUBE OF THE 10,7-CM SOLAR FLUX SBAR, SBAR3,          DRIVER,1818
336          SBAR3 = SBAR**3                                                  DRIVER,1819
      C           PRESCRIBE THE DERIVATIVE OF ALOG(NO) AT ALTITUDE Z8NO=125 KM, DRIVER,1820
      C           DLN08Z, TO BE GIVEN BY                                       DRIVER,1821
337          DLN08Z = 0.06573*SBAR3/(SBAR3+5.E5) - 0.07564 - 0.02703*DLN07Z   DRIVER,1822
      C           FOR LATER USE, COMPUTE                                       DRIVER,1823
345          ANOZ8 = ANOZ7*EXP(2.5*(DLN07Z+DLN08Z))                           DRIVER,1824
      C           IF(ZH.GE.Z7NO .AND. ZH.LT.Z8NO), THEN                        DRIVER,1825
      C              SNI(8)=ANOZ7*EXP(ZHM120*DLN07Z + 0.1*ZHM120**2*(DLN07Z-   DRIVER,1826
      C                     DLN08Z))                                           DRIVER,1827
      C           WHERE ZHM120=ZH-120,                                         DRIVER,1828
      C           IF(ZH.GE.Z8NO), THEN                                         DRIVER,1829
      C              SNI(8)=ANOZ8*EXP(ZHM125*DLN08Z)                           DRIVER,1830
      C           WHERE ZHM125=ZH-125 AND ANOZ8=ANOZ7*EXP(2.5*(DLN07Z+DLN08Z)), DRIVER,1831
      C           AT NIGHTTIME, NO DIFFERS FROM DAYTIME NO BELOW ALTITUDE Z4NON DRIVER,1832
      C           =85 KM AND ABOVE ALTITUDE Z5NON=100 KM,                      DRIVER,1833
      C           IF(ZH.LT.Z1NON), WHERE Z1NON=50 KM, NO=ANONZ1=ANONITE(11)=1.0,DRIVER,1834
      C           IF(ZH.GE.Z1NON .AND. ZH.LT.Z2NON), WHERE Z2NON=55 KM,        DRIVER,1835
      C              NO=ANONZ2*EXP((ZH-Z2NON)*ANONSI)                          DRIVER,1836
      C           WHERE                                                        DRIVER,1837
      C              ANONZ2=ANONIT(12)=1.E4                                    DRIVER,1838
      C              ANONSI=ALOG(ANONZ2/ANONZ1)/(Z2NON-Z1NON)                  DRIVER,1839
      C           IF(ZH.GE.Z2NON .AND. ZH.LT.Z4NON), WHERE Z4NON=85 KM,        DRIVER,1840
      C              SNI(8)=10.**SUM(X(I)*ZM2NON**(9-I)),I=1,9                 DRIVER,1841
      C           WHERE ZM2NON=ZH-Z2NON AND THE NINE COEFFICIENTS X(I) ARE     DRIVER,1842
      C           DETERMINED SO THAT NOT ONLY ALOG10(NO) EQUALS THE NIGHTTIME  DRIVER,1843
      C           VALUES FOR NO AT ZH=55(5)85 KM BUT ALSO THE SLOPE OF         DRIVER,1844
      C           ALOG10(NO) IS CONTINUOUS AT 55 AND 85 KM,                    DRIVER,1845
      C           THE NIGHTTIME CONSTANTS FOR ALTITUDES BELOW 85 KM ARE NOW SET,DRIVER,1846
352          Z1NON=ALTKM(11)                                                  DRIVER,1847
353          Z2NON=ALTKM(12)                                                  DRIVER,1848
354          ANONZ1=ANONIT(11)                                                DRIVER,1849
356          Z4NON = 85.                                                      DRIVER,1850
357          ANONZ2 = ANONIT(12)                                              DRIVER,1851
361          DO 120 I=2,8                                                     DRIVER,1852
370          ZINON(I) = ALTKM(I+10)                                           DRIVER,1853
371          ANONZI(I) = ANONIT(I+10)                                         DRIVER,1854
372      120 CONTINUE                                                         DRIVER,1855
373          ANONZI(8) = ANODAF( ZINON(8) )                                   DRIVER,1856
376          ANONSI = ALOG(ANONZI(2)/ANONZ1)/(ZINON(2)-Z1NON)                 DRIVER,1857
406          DLN02Z = ANONSI*ALOGTE                                           DRIVER,1858
407          X(8)   = DLN02Z                                                  DRIVER,1859
411          X(9)   = ALOG10(ANONZ2)                                          DRIVER,1860
413          DO 125 I=3,8                                                     DRIVER,1861
421          ZIM2NO(I) = ZINON(I)-ZINON(2)                                    DRIVER,1862
423      125 CONTINUE                                                         DRIVER,1863
424          DO 130 I=1,6                                                     DRIVER,1864
427          ZII2 = ZIM2NO(I+2)                                               DRIVER,1865
430          A(I,7) = ZII2*ZII2                                               DRIVER,1866
431          DO 130 J=1,6                                                     DRIVER,1867
435          A(I,7-J) = ZII2*A(I,8-J)                                         DRIVER,1868
443      130 CONTINUE                                                         DRIVER,1869
446          ZII8 = ZIM2NO(8)                                                 DRIVER,1870
447          A(7,7) = 2.*ZII8                                                 DRIVER,1871
451          DO 135 J=1,6                                                     DRIVER,1872
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MIN
457           FJ1 = J+1                                                     DRIVER,1873
461           A(7,7-J) = ZIIB*((FJ1+1.)/FJ1)*A(7,8-J)                       DRIVER,1874
473       135 CONTINUE                                                      DRIVER,1875
474           DO 140 I=1,6                                                  DRIVER,1876
477           A(I,8) = ALOG10(ANONZT(I+2)) - X(8)*ZTM2NO(I+2) - X(9)        DRIVER,1877
507       140 CONTINUE                                                      DRIVER,1878
512           Z8NON = ZINON(8)                                              DRIVER,1879
513           A(7,8) = ALOGTE * ((((((((((((12.*AA(13)*Z8NON                DRIVER,1880
         *          + 11.*AA(12))*Z8NON + 10.*AA(11))*Z8NON + 9.*AA(10))*Z8NON DRIVER,1881
         *          + 8.*AA(9))*Z8NON + 7.*AA(8))*Z8NON + 6.*AA(7))*Z8NON   DRIVER,1882
         *          + 5.*AA(6))*Z8NON + 4.*AA(5))*Z8NON + 3.*AA(4))*Z8NON   DRIVER,1883
         *          + 2.*AA(3))*Z8NON + AA(2)) - X(8)                       DRIVER,1884
547           NO = 7                                                        DRIVER,1885
550           CALL SOLVE(A,X,NO)                                            DRIVER,1886
      C            IF(ZH.GE.Z5NO), WHERE Z5NO=ALTKM(21)=100 KM,             DRIVER,1887
      C               ANONIT=ANODAY*((ZH-100.)**2 + 7200.)/(10.*(ZH-100.)**2 DRIVER,1888
      C                                                        + 7200.))    DRIVER,1889
      C           MOLECULAR OXYGEN (SINGLET DELTA G) PROFILE PARAMETERS.    DRIVER,1890
553           ZO2090 = ALTKM(19)                                            DRIVER,1891
554           ZO2100 = ALTKM(21)                                            DRIVER,1892
556           AO2090 = O2SDGD(19)                                           DRIVER,1893
560           BO2090 = -ALOG( O2SDGD(22)/AO2090 )/(ALTKM(22)-ZO2090)        DRIVER,1894
567           IF( IDURN )  142,150,150                                      DRIVER,1895
572       142 ZO2070 = ALTKM(15)                                            DRIVER,1896
573           ZO2080 = ALTKM(17)                                            DRIVER,1897
575           AO2070 = O2SDGN(15)                                           DRIVER,1898
576           AO2080 = O2SDGN(17)                                           DRIVER,1899
600           BO2070 = -ALOG( AO2080/AO2070 )/(ZO2080-ZO2070)               DRIVER,1900
607           Z(6) = ALOG10( AO2080 )                                       DRIVER,1901
612           DO 144 I=1,4                                                  DRIVER,1902
616           ZTI2 = ALTKM(I+17)-ZO2080                                     DRIVER,1903
620           A(I,5) = ZTI2                                                 DRIVER,1904
621           DO 144 J=1,4                                                  DRIVER,1905
626           A(I,5-J) = ZTI2*A(I,6-J)                                      DRIVER,1906
634       144 CONTINUE                                                      DRIVER,1907
637           ZTIB = ZO2100-ZO2080                                          DRIVER,1908
641           A(5,5) = 1.0                                                  DRIVER,1909
642           A(5,6) = -BO2090*ALOGTE                                       DRIVER,1910
645           DO 146 J=1,4                                                  DRIVER,1911
652           FJ = J                                                        DRIVER,1912
653           A(5,5-J) = ZTIB*((FJ+1.)/FJ)*A(5,6-J)                         DRIVER,1913
665       146 CONTINUE                                                      DRIVER,1914
667           DO 148 I=1,3                                                  DRIVER,1915
671           A(I,6) = ALOG10( O2SDGN(I+17) ) - Z(6)                        DRIVER,1916
700       148 CONTINUE                                                      DRIVER,1917
701           A(4,6) = ALOG10( AO2090*EXP(-BO2090*(ZO2100-ZO2090)) ) - Z(6) DRIVER,1918
713           NO = 5                                                        DRIVER,1919
714           CALL SOLVE(A,Z,NO)                                            DRIVER,1920
717           GO TO 156                                                     DRIVER,1921
721       150 ZO2050 = ALTKM(11)                                            DRIVER,1922
722           ZO2075 = ALTKM(16)                                            DRIVER,1923
724           AO2050 = O2SDGD(11)                                           DRIVER,1924
725           AO2075 = O2SDGD(16)                                           DRIVER,1925
727           BO2050 = -ALOG( AO2075/AO2050 )/(ZO2075-ZO2050)               DRIVER,1926
736           CALL FITTER(NALTO2,ALTKM,O2SDGD,NDGO2D, 1 , 2 ,DD)            DRIVER,1927
745           Y(6) = ALOG10( AO2075 )                                       DRIVER,1928
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747         Y(5) = -BO2050*ALOGTE
752         DO 152 I=1,3
757         ZII2 = ALTKM(I+16)-ZO2075
760         A(I,4) = ZII2*ZII2
761         A(I,5) = ALOG10( O2SDGD(I+16) ) - ZII2*Y(5) - Y(6)
770         DO 152 J=1,3
776         A(I,4-J) = ZII2*A(I,5-J)
1004    152 CONTINUE
1007        ZII8 = ZO2090-ZO2075
1011        A(4,4) = 2.*ZII8
1012        A(4,5) = -BO2090*ALOGTE - Y(5)
1016        DO 154 J=1,3
1023        FJ = J+1
1025        A(4,4-J) = ZII8*((FJ+1.)/FJ)*A(4,5-J)
1037    154 CONTINUE
1040        NO = 4
1041        CALL SOLVE(A,Y,NO)
1046    156 CONTINUE
      C           O3 (OZONE) PROFILE PARAMETERS.
1046        ZO3D40 = ALTKM( 9)
1047        ZO3D75 = ALTKM(16)
1051        AO3D40 = O3DAY( 9)
1053        BO3D40 = -ALOG( O3DAY(16)/AO3D40 )/(ZO3D75-ZO3D40)
1062        EE(10) = ALOG10( O3DAY( 1) )
1065        DO 158 I=1,8
1071        ZII2 = ALTKM(I+1)
1072        A(I,9) = ZII2
1074        A(I,10) = ALOG10( O3DAY(I+1) ) - EE(10)
1101        DO 158 J=1,8
1107        A(I,9-J) = ZII2*A(I,10-J)
1115    158 CONTINUE
1120        ZII8 = ZO3D40
1121        A(9,9) = 1.0
1123        A(9,10) = -BO3D40*ALOGTE
1125        DO 160 J=1,8
1133        FJ = J
1134        A(9,9-J) = ZII8*((FJ+1.)/FJ)*A(9,10-J)
1146    160 CONTINUE
1150        NO = 9
1151        CALL SOLVE(A,EE,NO)
1153        IF( IDURN )  162,172,172
1156    162 ZO3N55 = ALTKM(12)
1157        ZO3N70 = ALTKM(15)
1161        ZO3N75 = ALTKM(16)
1162        AO3N70 = O3NIT(15)
1164        BO3N70 = -ALOG( O3NIT(16)/AO3N70 )/(ZO3N75-ZO3N70)
1173        VO3(6) = ALOG10( AO3D40*EXP(-BO3D40*(ZO3N55-ZO3D40)) )
1203        VO3(5) = -BO3D40*ALOGTE
1206        DO 164 I=1,3
1213        ZII2 = ALTKM(I+12) - ZO3N55
1214        A(I,4) = ZII2*ZII2
1215        A(I,5) = ALOG10( O3NIT(I+12) ) - ZII2*VO3(5) - VO3(6)
1224        DO 164 J=1,3
1232        A(I,4-J) = ZII2*A(I,5-J)
1240    164 CONTINUE
1243        ZII8 = ZO3N70-ZO3N55
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1245          A(4,4) = 2.*ZII8                                              DRIVER,1985
1246          A(4,5) = -B03N70*ALOGTE - V03(5)                              DRIVER,1986
1252          DO 166 J=1,3                                                  DRIVER,1987
1257          FJ = J+1                                                      DRIVER,1988
1261          A(4,4-J) = ZII8*((FJ+1.)/FJ)*A(4,5-J)                         DRIVER,1989
1273      166 CONTINUE                                                      DRIVER,1990
1274          NO = 4                                                        DRIVER,1991
1275          CALL SOLVE(A,V03,NO)                                          DRIVER,1992
1300          Z03N90 = ALTKM(19)                                            DRIVER,1993
1301          A03N90 = O3NIT(19)                                            DRIVER,1994
1303          B03N90 = -ALOG( O3NIT(22)/A03N90 )/(ALTKM(22)-Z03N90)         DRIVER,1995
1313          W03(6) = ALOG10( O3NIT(16) )                                  DRIVER,1996
1315          W03(5) = -B03N70*ALOGTE                                       DRIVER,1997
1320          DO 168 I=1,3                                                  DRIVER,1998
1325          ZII2 = ALTKM(I+16) - Z03N75                                   DRIVER,1999
1326          A(I,4) = ZII2*ZII2                                            DRIVER,2000
1327          A(I,5) = ALOG10( O3NIT(I+16) ) - ZII2*W03(5) - W03(6)         DRIVER,2001
1336          DO 168 J=1,3                                                  DRIVER,2002
1344          A(I,4-J) = ZII2*A(I,5-J)                                      DRIVER,2003
1352      168 CONTINUE                                                      DRIVER,2004
1355          ZII8 = Z03N90-Z03N75                                          DRIVER,2005
1357          A(4,4) = 2.*ZII8                                              DRIVER,2006
1360          A(4,5) = -B03N90*ALOGTE - W03(5)                              DRIVER,2007
1364          DO 170 J=1,3                                                  DRIVER,2008
1371          FJ = J+1                                                      DRIVER,2009
1373          A(4,4-J) = ZII8*((FJ+1.)/FJ)*A(4,5-J)                         DRIVER,2010
1405      170 CONTINUE                                                      DRIVER,2011
1406          NO = 4                                                        DRIVER,2012
1407          CALL SOLVE(A,W03,NO)                                          DRIVER,2013
1412          GO TO 178                                                     DRIVER,2014
1414      172 Z03D90 = ALTKM(19)                                            DRIVER,2015
1415          A03D90 = O3DAY(19)                                            DRIVER,2016
1417          B03D90 = -ALOG( O3DAY(22)/A03D90 )/(ALTKM(22)-Z03D90)         DRIVER,2017
1427          U03(6) = ALOG10( O3DAY(16) )                                  DRIVER,2018
1431          U03(5) = -B03D40*ALOGTE                                       DRIVER,2019
1434          DO 174 I=1,3                                                  DRIVER,2020
1441          ZII2 = ALTKM(I+16) - Z03D75                                   DRIVER,2021
1442          A(I,4) = ZII2*ZII2                                            DRIVER,2022
1443          A(I,5) = ALOG10( O3DAY(I+16) ) - ZII2*U03(5) - U03(6)         DRIVER,2023
1452          DO 174 J=1,3                                                  DRIVER,2024
1460          A(I,4-J) = ZII2*A(I,5-J)                                      DRIVER,2025
1466      174 CONTINUE                                                      DRIVER,2026
1471          ZII8 = Z03D90-Z03D75                                          DRIVER,2027
1473          A(4,4) = 2.*ZII8                                              DRIVER,2028
1474          A(4,5) = -B03D90*ALOGTE - U03(5)                              DRIVER,2029
1500          DO 176 J=1,3                                                  DRIVER,2030
1505          FJ = J+1                                                      DRIVER,2031
1507          A(4,4-J) = ZII8*((FJ+1.)/FJ)*A(4,5-J)                         DRIVER,2032
1521      176 CONTINUE                                                      DRIVER,2033
1522          NO = 4                                                        DRIVER,2034
1523          CALL SOLVE(A,U03,NO)                                          DRIVER,2035
1530      178 CONTINUE                                                      DRIVER,2036
      C           FIT COEFFICIENTS FOR NO2 (DAY AND NIGHT).                 DRIVER,2037
1530          CALL FITTER(NKMNO2,ALTKM,SNO2D,NDGNO2, 1 , 2 ,HH)            DRIVER,2038
1537          HNO21D = ALTKM(29)                                            DRIVER,2039
1540          HNO22D = ALTKM(33)                                            DRIVER,2040
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1542          ANO2FD = ANO2FF( HNO22D )                                         DRIVER,2041
1545          HNO2DD = HNO21D-HNO22D                                            DRIVER,2042
1547          RNO212 = ANO2FF( HNO21D ) / ANO2FD                                DRIVER,2043
1552          FNO255 = ANO2FF( 55. ) + ANODAF( 55. ) - ANONZ2                   DRIVER,2044
1563          ANO265 = SNO2N(14)                                                DRIVER,2045
1564          HNO255 = ALTKM(12)                                                DRIVER,2046
1566          HNO265 = ALTKM(14)                                                DRIVER,2047
1567          HNO2DN = HNO255-HNO265                                            DRIVER,2048
1571          RNO2FA = FNO255/ANO265                                            DRIVER,2049
1573          ANO282 = ANO2FF( 82. )                                            DRIVER,2050
1576          HNO282 = 82.                                                      DRIVER,2051
1577          HNO2D8 = HNO265-HNO282                                            DRIVER,2052
1600          RNO282 = ANO265/ANO282                                            DRIVER,2053
      C          FIT COEFFICIENTS FOR H2O.                                      DRIVER,2054
1603          CALL FITTER(NKMH2O,ALTKM,H2ODN,NDGH2O, 1 , 2 ,GG)                 DRIVER,2055
1611          H2O120 = AH2OFF( 120. )                                           DRIVER,2056
1615          RETURN                                                            DRIVER,2057
1615      200 CONTINUE                                                          DRIVER,2058
      CCC                                                                       DRIVER,2059
      C          AN ERRONEOUS CONDITION WILL OCCUR IF SPCHIN IS CALLED WITH     DRIVER,2060
      C          KK=2 AND A GIVEN VALUE OF ZH IF ATMOSU HAS NOT BEEN CALLED     DRIVER,2061
      C          FIRST WITH KK=2 AND FOR THE SAME VALUE OF ZH.                  DRIVER,2062
      C          THE VARIABLE ZHFLAG IS USED TO DETECT THIS CONDITION AND       DRIVER,2063
      C          TO MAKE THE REQUIRED CALL TO ATMOSU.                           DRIVER,2064
      C          ZHFLAG IS INITIALIZED TO AN ARBITRARY NEGATIVE VALUE IN        DRIVER,2065
      C          THE INITIALIZATION CALL TO ATMOSU.                             DRIVER,2066
      CCC                                                                       DRIVER,2067
1615          IF( ZH.NE.ZHFLAG )  CALL ATMOSU(2,ZH)                             DRIVER,2068
      C          COMPUTE DENSITY OF N                                           DRIVER,2069
1621          IF( IDORN )  210,215,215                                          DRIVER,2070
      C          NIGHTTIME N                                                    DRIVER,2071
1625      210 IF( ZH-Z2NN )  212,211,211                                        DRIVER,2072
1630      211 SNI(7) = (ANNZ2/S1Z2N)*SNI(1)                                     DRIVER,2073
1633          GO TO 220                                                         DRIVER,2074
1633      212 IF( ZH-Z1NN )  214,213,213                                        DRIVER,2075
1636      213 SNI(7) = ANNAF( ZH )                                              DRIVER,2076
1641          GO TO 220                                                         DRIVER,2077
1641      214 SNI(7) = ANNZ1                                                    DRIVER,2078
1643          GO TO 220                                                         DRIVER,2079
      C          DAYTIME N                                                      DRIVER,2080
1643      215 IF( ZH-Z2ND )  217,216,216                                        DRIVER,2081
1646      216 SNI(7) = (ANDZ2/S1Z2N)*SNI(1)                                     DRIVER,2082
1651          GO TO 220                                                         DRIVER,2083
1651      217 IF( ZH-Z1ND )  219,218,218                                        DRIVER,2084
1654      218 SNI(7) = ANDAF( ZH )                                              DRIVER,2085
1657          GO TO 220                                                         DRIVER,2086
1657      219 SNI(7) = ANDZ1                                                    DRIVER,2087
1661      220 CONTINUE                                                          DRIVER,2088
      C          COMPUTE DENSITY OF NO                                          DRIVER,2089
1661          IF(ZH-Z7NO) 226,221,221                                           DRIVER,2090
1664      221 IF(ZH-Z8NO) 223,222,222                                           DRIVER,2091
1667      222 ZHMZ8 = ZH-Z8NO                                                   DRIVER,2092
1671          SNI(8) = ANOZ8*EXP(ZHMZ8*DLNO8Z)                                  DRIVER,2093
1676          GO TO 224                                                         DRIVER,2094
1700      223 ZHMZ7 = ZH - Z7NO                                                 DRIVER,2095
1702          SNI(8) = ANOZ7*EXP(ZHMZ7*DLNO7Z-0.1*ZHMZ7**2*(DLNO7Z-DLNO8Z))     DRIVER,2096
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1714     224 IF( IDORN.GE.0 ) GO TO 229                                       DRIVER.2097
1717     225 ZHMZ52 = (ZH-100.)**2                                             DRIVER.2098
1720         SNI(8) = SNI(8)*(ZHMZ52+7200.)/(10.*ZHMZ52+7200.)                 DRIVER.2099
1725         GO TO 229                                                         DRIVER.2100
1725     226 IF( IDORN.GE.0 .OR. ZH.GE.Z4NON ) GO TO 2283                      DRIVER.2101
1736         IF( ZH-Z2NON ) 228,227,227                                        DRIVER.2102
1741     227 ZM2NON = ZH-Z2NON                                                 DRIVER.2103
1742         SNI(8) = 10.**((((((((X(1)*ZM2NON + X(2))*ZM2NON + X(3))*ZM2NON   DRIVER.2104
        *              + X(4))*ZM2NON + X(5))*ZM2NON + X(6))*ZM2NON            DRIVER.2105
        *              + X(7))*ZM2NON + X(8))*ZM2NON + X(9))                   DRIVER.2106
1763         GO TO 229                                                         DRIVER.2107
1764     228 IF( ZH-Z1NON ) 2282,2281,2281                                     DRIVER.2108
1767    2281 ZM2NON = ZH-Z2NON                                                 DRIVER.2109
1771         SNI(8) = ANONZ2*EXP(ZM2NON*ANONSI)                                DRIVER.2110
1776         GO TO 229                                                         DRIVER.2111
2000    2282 SNI(8) = ANONZ1                                                   DRIVER.2112
2002         GO TO 229                                                         DRIVER.2113
2002    2283 SNI(8) = ANODAF( ZH )                                             DRIVER.2114
2004         IF( IDORN.GE.0 .OR. ZH.LT.100. ) GO TO 229                        DRIVER.2115
2014         GO TO 225                                                         DRIVER.2116
2014     229 CONTINUE                                                          DRIVER.2117
       C          COMPUTE DENSITY OF O2(1 DELTA G)                             DRIVER.2118
2014         IF( ZH.LT.ZO2100 )  GO TO 231                                     DRIVER.2119
2017     230 SNI(13) = AO2090*EXP(-BO2090*(ZH-ZO2090))                         DRIVER.2120
2026         GO TO 238                                                         DRIVER.2121
2030     231 IF( IDORN )  232,235,235                                          DRIVER.2122
       C          NIGHTTIME O2(1 DELTA G)                                      DRIVER.2123
2032     232 IF( ZH.GT.ZO2070 )  GO TO 233                                     DRIVER.2124
2036         SNI(13) = AO2070                                                  DRIVER.2125
2037         GO TO 238                                                         DRIVER.2126
2037     233 IF( ZH.GT.ZO2080 )  GO TO 234                                     DRIVER.2127
2043         SNI(13) = AO2070*EXP(-BO2070*(ZH-ZO2070))                         DRIVER.2128
2052         GO TO 238                                                         DRIVER.2129
2054     234 ZHMKM = ZH-ZO2080                                                 DRIVER.2130
2055         SNI(13) = 10.**(((((Z(1)*ZHMKM + Z(2))*ZHMKM + Z(3))*ZHMKM        DRIVER.2131
        *                    + Z(4))*ZHMKM + Z(5))*ZHMKM + Z(6))               DRIVER.2132
2071         GO TO 238                                                         DRIVER.2133
       C          DAYTIME O2(1 DELTA G)                                        DRIVER.2134
2072     235 IF( ZH.GE.ZO2090 )  GO TO 230                                     DRIVER.2135
2075         IF( ZH.GE.ZO2050 )  GO TO 236                                     DRIVER.2136
2077         SNI(13) = AO2SDF( ZH )                                            DRIVER.2137
2101         GO TO 238                                                         DRIVER.2138
2101     236 IF( ZH.GT.ZO2075 )  GO TO 237                                     DRIVER.2139
2105         SNI(13) = AO2050*EXP(-BO2050*(ZH-ZO2050))                         DRIVER.2140
2114         GO TO 238                                                         DRIVER.2141
2116     237 ZHMKM = ZH-ZO2075                                                 DRIVER.2142
2117         SNI(13) = 10.**(((((Y(1)*ZHMKM + Y(2))*ZHMKM + Y(3))*ZHMKM        DRIVER.2143
        *                    + Y(4))*ZHMKM + Y(5))*ZHMKM + Y(6))               DRIVER.2144
2133     238 CONTINUE                                                          DRIVER.2145
       C          COMPUTE DENSITY OF O3 (OZONE)                                DRIVER.2146
2133         IF( ZH.LT.ZO3D40 )  GO TO 243                                     DRIVER.2147
2136         IF( IDORN )  239,244,244                                          DRIVER.2148
       C          NIGHTTIME O3                                                 DRIVER.2149
2137     239 IF( ZH.LT.ZO3N55 )  GO TO 244                                     DRIVER.2150
2142         IF( ZH.GE.ZO3N70 )  GO TO 240                                     DRIVER.2151
2144         ZHMKM = ZH-ZO3N55                                                 DRIVER.2152
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2145          SNI(14) = 10.**(((((VO3(1)*ZHMKM + VO3(2))*ZHMKM + VO3(3))*ZHMKM
             *                   + VO3(4))*ZHMKM + VO3(5))*ZHMKM + VO3(6))
2161          GO TO 247
2162      240 IF( ZH.GT.ZO3N75 )  GO TO 241
2166          SNI(14) = AO3N70*EXP(-BO3N70*(ZH-ZO3N70))
2175          GO TO 247
2176      241 IF( ZH.GE.ZO3N90 )  GO TO 242
2201          ZHMKM = ZH-ZO3N75
2203          SNI(14) = 10.**(((((WO3(1)*ZHMKM + WO3(2))*ZHMKM + WO3(3))*ZHMKM
             *                   + WO3(4))*ZHMKM + WO3(5))*ZHMKM + WO3(6))
2217          GO TO 247
2220      242 SNI(14) = AO3N90*EXP(-BO3N90*(ZH-ZO3N90))
2227          GO TO 247
            C      IF ZH.LT.40. , BOTH DAY AND NIGHT USE FOLLOWING.
2231      243 SNI(14) = 10.**((((((((((EE(1)*ZH + EE(2))*ZH + EE(3))*ZH
             *           + EE(4))*ZH + EE(5))*ZH + EE(6))*ZH + EE(7))*ZH
             *           + EE(8))*ZH + EE(9))*ZH + EE(10))
2253          GO TO 247
            C      DAYTIME O3
2254      244 IF( ZH.GT.ZO3D75 )  GO TO 245
2260          SNI(14) = AO3D40*EXP(-BO3D40*(ZH-ZO3D40))
2267          GO TO 247
2270      245 IF( ZH.GE.ZO3D90 )  GO TO 246
2273          ZHMKM = ZH-ZO3D75
2275          SNI(14) = 10.**(((((UO3(1)*ZHMKM + UO3(2))*ZHMKM + UO3(3))*ZHMKM
             *                   + UO3(4))*ZHMKM + UO3(5))*ZHMKM + UO3(6))
2311          GO TO 247
2312      246 SNI(14) = AO3D90*EXP(-BO3D90*(ZH-ZO3D90))
2322      247 CONTINUE
            C      COMPUTE DENSITY OF NO2
2322          IF( IDORN )  248,252,252
            C      NIGHTTIME NO2
2324      248 IF( ZH.GE.HNO255 )  GO TO 250
2327          SNI(15) = ANO2FF( ZH ) + ANODAF( ZH ) - SNI(8)
2335          GO TO 261
2336      250 IF( ZH.GT.HNO265 )  GO TO 251
2342          SNI(15) = ANO265 * RNO2FA**((ZH-HNO265)/HNO2DN)
2350          GO TO 261
2350      251 IF( ZH.GT.HNO282 )  GO TO 252
2354          SNI(15) = ANO282 * RNO282**((ZH-HNO282)/HNO2D8)
2362          GO TO 261
            C      DAYTIME NO2
2362      252 IF( ZH.GT.HNO22D )  GO TO 253
2366          SNI(15) = ANO2FF( ZH )
2370          GO TO 261
2370      253 SNI(15) = ANO2FD * RNO212**((ZH-HNO22D)/HNO2DD)
2377      261 CONTINUE
            C      COMPUTE DENSITY OF H2O  (DAY OR NIGHT)
2377          IF( ZH.GE.120. ) GO TO 262
2402          SNI(16) = AH2OFF( ZH )
2404          GO TO 263
2404      262 SNI(16) = H2O120*EXP(-0.166*(ZH-120.))
2413      263 CONTINUE
2413      299 RETURN
2414          END
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ZTTOUT

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      SUBROUTINE ZTTOUT                                                 DRIVER.2208
CCC                                                                     DRIVER.2209
C          SUBROUTINE ZTTOUT CONVERTS A GREGORIAN CALENDAR DATE (20 TH   DRIVER.2210
C          CENTURY YEAR IYRS, MONTH IMONS, DAY IDAYS) AND ZONE TIME ZT  DRIVER.2211
C          AT EAST LONGITUDE PLON TO GREGORIAN CALENDAR DATE AND MEAN   DRIVER.2212
C          TIME UT AT GREENWICH.                                        DRIVER.2213
CCC                                                                     DRIVER.2214
C          REVISION 02 (11/18/74) PROVIDES...                           DRIVER.2215
C             1. TEST FOR LEGAL INPUT DATE.                             DRIVER.2216
C     INPUT PARAMETERS                                                  DRIVER.2217
C               IYRS - NUMBER OF THE YEAR IN THE 1900 S (E.G., 1974     DRIVER.2218
C                      BECOMES 74).                                     DRIVER.2219
C              IMONS - NUMBER OF THE MONTH (E.G., FEBRUARY BECOMES 2).  DRIVER.2220
C              IDAYS - DAY OF THE MONTH                                 DRIVER.2221
C                 ZT - ZONE TIME FOR THE 15-DEGREE LONGITUDE INTERVAL   DRIVER.2222
C                      CONTAINING PLON (DECIMAL HRS)                    DRIVER.2223
C               PLON - EAST LONGITUDE OF POINT P (RADIANS)              DRIVER.2224
CCC                                                                     DRIVER.2225
C     OUTPUT PARAMETERS                                                 DRIVER.2226
C               IYRS - A POSSIBLY REVISED VALUE OF THE INPUT PARAMETER, DRIVER.2227
C                      CORRESPONDING TO GREENWICH.                      DRIVER.2228
C              IMONS - A POSSIBLY REVISED VALUE OF THE INPUT PARAMETER, DRIVER.2229
C                      CORRESPONDING TO GREENWICH.                      DRIVER.2230
C              IDAYS - A POSSIBLY REVISED VALUE OF THE INPUT PARAMETER, DRIVER.2231
C                      CORRESPONDING TO GREENWICH.                      DRIVER.2232
C                 UT - UNIVERSAL TIME (DECIMAL HRS)                     DRIVER.2233
CCC                                                                     DRIVER.2234
C     DEFINITION OF DATA                                                DRIVER.2235
C          IDAYMO(I) = DAYS IN THE I TH MONTH OF A NON-LEAP YEAR        DRIVER.2236
CCC                                                                     DRIVER.2237
      COMMON/TIME/  IYRS,IMONS,IDAYS,ZT,PLAT,PLON,UT,GAT                DRIVER.2238
      DIMENSION  IDAYMO(12)                                             DRIVER.2239
      DATA  (IDAYMO(I),I=1,12) / 31,28,31,30,31,30,31,31,30,31,30,31 /  DRIVER.2240
      DATA  PI / 3.14159265359O /                                       DRIVER.2241
CCC                                                                     DRIVER.2242
C          CONVERSION FROM ZONE TIME ZT TO GREENWICH MEAN TIME (I.E.,   DRIVER.2243
C          UNIVERSAL TIME UT) IS DONE BY FIRST FINDING THE TIME ZONE    DRIVER.2244
C          CONTAINING THE LONGITUDE PLON.                               DRIVER.2245
C          N7PTS IS THE INTEGRAL NUMBER OF 7.5-DEGREE INTERVALS IN THE  DRIVER.2246
C          WESTERLY DIRECTION FROM GREENWICH TO THE LONGITUDE OF INTERESTDRIVER.2247
C          PLON.  N7PTS MAY BE 0 OR ANY INTEGER UP TO AND INCLUDING 47. DRIVER.2248
C          HOWEVER, THE TIME-ZONE NUMBER IZONE IS 0 FOR N7PTS EQUAL TO  DRIVER.2249
C          0 OR 47.  IZONE RANGES FROM 0 TO 23.                         DRIVER.2250
CCC                                                                     DRIVER.2251
C          TEST WHETHER INPUT DATE IS LEGAL.                            DRIVER.2252
      IF( ZT.LT.0.0 .OR. ZT.GE.24. )  GO TO 999                         DRIVER.2253
      IF( IYRS.LT.1 .OR. IYRS.GT.99 )  GO TO 999                        DRIVER.2254
      IF( IMONS.LT.1 .OR. IMONS.GT.12 )  GO TO 999                      DRIVER.2255
C          IF YRS IS A LEAP YEAR, SET IDAYMO(2) = 29                    DRIVER.2256
      LEAP = MOD(IYRS,4)                                                DRIVER.2257
      IF( LEAP.EQ.0 )  IDAYMO(2) = 29                                   DRIVER.2258
      IF( IDAYS.LT.1 .OR. IDAYS.GT.IDAYMO(IMONS) )  GO TO 999           DRIVER.2259
      PI2 = 2.*PI                                                       DRIVER.2260
      PID2 = PI/2.                                                      DRIVER.2261
      RADDEG = PI/180.                                                  DRIVER.2262
      N7PTS = (PI2-PLON)/(7.5*RADDEG)                                   DRIVER.2263
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 53         IF( NZPTS-47 )  10,20,20                                          DRIVER,2264
 56      10 IZONE = (NZPTS+1)/2                                               DRIVER,2265
 61         GO TO 30                                                          DRIVER,2266
 61      20 IZONE = 0                                                         DRIVER,2267
 62      30 ZONE = FLOAT(IZONE)                                               DRIVER,2268
      CCC                                                                     DRIVER,2269
      C          SHIFT TO CONVENTIONAL ZONE DESCRIPTION, ZD (SEE, E.G.,       DRIVER,2270
      C          AMERICAN PRACTICAL NAVIGATOR (ORIGINALLY BY N. BOWDITCH),    DRIVER,2271
      C          U.S. NAVY H.O. PUB. NO. 9, P.489, OF 1962 CORRECTED REPRINT  DRIVER,2272
      C          EDITION, AVAILABLE FROM U.S. GOV. PRINTING OFFICE).          DRIVER,2273
      CCC                                                                     DRIVER,2274
 63         IF( PLON.GT.PI )  GO TO 35                                        DRIVER,2275
 67         ZD = ZONE-24.                                                     DRIVER,2276
 70         GO TO 40                                                          DRIVER,2277
 71      35 ZD = ZONE                                                         DRIVER,2278
 73      40 UT = ZT+ZD                                                        DRIVER,2279
      C          MUST SHIFT TO NEXT DAY IF(UT.GE.24.)                         DRIVER,2280
 75         IF( UT.GE.24. )  GO TO 50                                         DRIVER,2281
      C          MUST SHIFT TO PREVIOUS DAY IF(UT.LT.0.)                      DRIVER,2282
100         IF( UT.LT.0.0 )  GO TO 45                                         DRIVER,2283
      C          NO SHIFT IS NECESSARY IF(UT.GE.0.0 .AND. UT.LT.24.)          DRIVER,2284
101         GO TO 60                                                          DRIVER,2285
101      45 UT = UT+24.                                                       DRIVER,2286
103         IDAYS = IDAYS-1                                                   DRIVER,2287
      C          CORRECT MONTH AND YEAR IF NECESSARY, DUE TO CHANGING THE DATE DRIVER,2288
      C          IN CONVERTING TO UT.                                         DRIVER,2289
      C          CORRECT IDAYS AND IMONS IF MONTH DECREASED AT GREENWICH      DRIVER,2290
105         IF( IDAYS.GE.1 )  GO TO 60                                        DRIVER,2291
106         IDAYS = IDAYMO(IMONS-1)                                           DRIVER,2292
110         IMONS = IMONS-1                                                   DRIVER,2293
      C          CORRECT IMONS AND IYRS IF YEAR DECREASED AT GREENWICH        DRIVER,2294
111         IF( IMONS.GE.1 )  GO TO 60                                        DRIVER,2295
112         IMONS = 12                                                        DRIVER,2296
113         IYRS = IYRS-1                                                     DRIVER,2297
115         GO TO 60                                                          DRIVER,2298
115      50 UT = UT-24.                                                       DRIVER,2299
117         IDAYS = IDAYS+1                                                   DRIVER,2300
      C          CORRECT MONTH AND YEAR IF NECESSARY, DUE TO CHANGING THE DATE DRIVER,2301
      C          IN CONVERTING TO UT.                                         DRIVER,2302
      C          IF YRS IS A LEAP YEAR, SET IDAYMO(2) = 29                    DRIVER,2303
121         LEAP = MOD(IYRS,4)                                                DRIVER,2304
123         IF(  LEAP.EQ.0  )  IDAYMO(2) = 29                                 DRIVER,2305
      C          CORRECT IDAYS AND IMONS IF MONTH INCREASED AT GREENWICH      DRIVER,2306
125         IF( IDAYS.LE.IDAYMO(IMONS) )  GO TO 60                            DRIVER,2307
130         IDAYS = 1                                                         DRIVER,2308
130         IMONS = IMONS+1                                                   DRIVER,2309
      C          CORRECT IMONS AND IYRS IF YEAR INCREASED AT GREENWICH        DRIVER,2310
132         IF( IMONS.LE.12 )  GO TO 60                                       DRIVER,2311
134         IMONS = 1                                                         DRIVER,2312
134         IYRS = IYRS+1                                                     DRIVER,2313
136      60 RETURN                                                            DRIVER,2314
137     999 WRITE(6,777)                                                      DRIVER,2315
        777 FORMAT (40H0   * * * ILLEGAL DATE INPUTTED * * *     )            DRIVER,2316
143         CALL EXIT                                                         DRIVER,2317
144         END                                                               DRIVER,2318
```

CHEMQ

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          SUBROUTINE CHEMQ(QDELAY,ENPQ,OPQ,ENEQ)
      C
      C   STEADY-STATE IONIZATION FOR THE E- AND F-REGION
      C
      C   THE FOLLOWING EQUATION SET IS SOLVED
      C
      C       0 = -ALPHAR*(N+)*(E) - BETAN*(N+) - K*(O)*(N+) + QN
      C
      C       0 = -ALPHAR*(O+)*(E) - BETAO*(O+) + K*(O)*(N+) + QO
      C
      C       0 = -ALPHAD*(M+)*(E) + BETAN*(N+) + BETAO*(O+) + QM
      C
      C       INPUT FROM CALL SEQUENCE
      C   QDELAY = DELAYED RADIATION ION PRODUCTION RATE (CM-3*SEC-1)
      C       OUTPUTS TO CALL SEQUENCE
      C   ENPQ  = STEADY-STATE CONCENTRATION OF (N+) (CM-3)
      C   OPQ   = STEADY-STATE CONCENTRATION OF (O+)  (CM-3)
      C   ENEQ  = STEADY-STATE CONCENTRATION OF ELECTRONS (CM-3)
      C       INPUTS FROM SPECQ COMMON
      C   SPECIES CONCENTRATIONS, CN2 = (N2), CO2 = (O2), ... , CNP = (N+),
      C       ETC. (CM-3)
      C   TV    = NITROGEN VIBRATION TEMPERATURE (DEG K)
      C   TE    = ELECTRON, OXYGEN EXCITATION TEMPERATURE (DEG K)
      C   TG    = GAS TEMPERATURE (DEG K)
      C
          COMMON /SPECQ / CN2,CO2,CNO,CN4S,CN2D,CO,CNP,COP,CENE,TV,TE,TG
      C
          CMP = CENE - COP - CNP
 10       CAT=2.*(CN2+CO2+CNO)+CN4S+CN2D+CO
      C       REACTION RATES
      C       ATOMIC ION RECOMBINATION
 20       ALPHAR=RATE(11,TE)+RATE(12,TE)*CENE+1.5E-07*SQRT(CENE)/(TE**3)
      C       MOLECULAR ION RECOMBINATION
 36       ALPHAD=RATE(13,TE)+RATE(14,TE)
      C       (N+) LOSS
 46       XNPO=RATE(5,TG)*CO
 51       BETAN=RATE(4,TG)*CN2+(RATE(1,TG)+RATE(2,TG))*CO2+RATE(5,TG)*CNO+
         1 XNPO
      C       (O+) LOSS
 74       BETAO=RATE(10,TV)*CN2+RATE(9,TG)*CO2
      C       ION PRODUCTION RATES
110       QM=2.*(CN2+CO2+CNO)/CAT*QDELAY
114       QN=(CN4S+CN2D)/CAT*QDELAY
117       QO=CO/CAT*QDELAY
121       QA=QN+QO
123       ATERM=SQRT(QA*ALPHAR)
127       QO1=QO+XNPO*QN/(BETAN+ATERM)
      C       FRACTION FN = (N+)/(A+), FO = (O+)/(A+)
133       FN=(QN*(BETAO+ATERM))/((QN*(BETAO+ATERM))+QO1*(BETAN+ATERM))
140       FO=1.-FN
      C       EFFECTIVE ATOMIC ION LOSS RATE
142       BETRAR=FN*BETAN+FO*BETAO
      C       EQUILIBRIUM ATOMIC ION CONCENTRATIONS
145       B=0.5*BETRAR/ALPHAR
147       A=QA/ALPHAR
150       IF(B*B-1000.*A)10,11,11
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156      10 APQ=-B+SQRT(B*B+A)                                              DRIVER,2375
164         GO TO 12                                                        DRIVER,2376
167      11 APQ=0.5*A/B                                                     DRIVER,2377
172      12 ENPQ=FN*APQ                                                     DRIVER,2378
174         DPQ=FD*APQ                                                      DRIVER,2379
      C           EQUILIBRIUM ELECTRON DENSITY                              DRIVER,2380
175         ENEQ=(0.5*APQ)+SQRT((0.5*APQ)**2+(QM+BETBAR*APQ)/ALPHAD)        DRIVER,2381
      C                                                                     DRIVER,2382
210         RETURN                                                          DRIVER,2383
211         END                                                             DRIVER,2384
```

```
TEST VALUES READ IN

NALTS =  130

         I    ALTS(I),KM

         1       0.00      2       5.00      3      10.00      4      15.00      5      20.00      6      25.00
         7      30.00      8      35.00      9      40.00     10      45.00     11      50.00     12      55.00
        13      56.00     14      57.00     15      58.00     16      59.00     17      60.00     18      61.00
        19      62.00     20      63.00     21      64.00     22      65.00     23      66.00     24      67.00
        25      68.00     26      69.00     27      70.00     28      71.00     29      72.00     30      73.00
        31      74.00     32      75.00     33      76.00     34      77.00     35      78.00     36      79.00
        37      80.00     38      81.00     39      82.00     40      83.00     41      84.00     42      85.00
        43      86.00     44      87.00     45      88.00     46      89.00     47      90.00     48      95.00
        49     100.00     50     101.00     51     102.00     52     103.00     53     104.00     54     105.00
        55     106.00     56     107.00     57     108.00     58     109.00     59     110.00     60     111.00
        61     112.00     62     113.00     63     114.00     64     115.00     65     116.00     66     117.00
        67     118.00     68     119.00     69     119.99     70     120.00     71     121.00     72     122.00
        73     123.00     74     124.00     75     125.00     76     130.00     77     135.00     78     140.00
        79     145.00     80     150.00     81     160.00     82     170.00     83     180.00     84     190.00
        85     200.00     86     220.00     87     240.00     88     260.00     89     280.00     90     300.00
        91     320.00     92     340.00     93     360.00     94     380.00     95     400.00     96     420.00
        97     440.00     98     460.00     99     480.00    100     500.00    101     520.00    102     540.00
       103     560.00    104     580.00    105     600.00    106     620.00    107     640.00    108     660.00
       109     680.00    110     700.00    111     720.00    112     740.00    113     760.00    114     780.00
       115     800.00    116     820.00    117     840.00    118     860.00    119     880.00    120     900.00
       121     920.00    122     940.00    123     960.00    124     980.00    125    1000.00    126    1040.00
       127    1080.00    128    1120.00    129    1160.00    130    1200.00

 IYRS =   77   IMONS =    9   IDAYS =    1
   ZT =  1.2000E+01 HRS      GCO =  5.5000E+01 DEG     GLO =  2.3500E+02 DEG

INITIALIZATION CALL


TIF =  1.444019E+03 TAU =  1.480683E-02


 IYRS =   77   IMONS =    9   IDAYS =    1
   ZT =  1.2000E+01 HRS      GCO =  9.5993E-01 RAD     GLO =  4.1015E+00 RAD

IDORN =    1      UT =  2.0000E+01     GAT =  1.9994E+01    PLAT =  6.1087E-01    PLON =  4.1015E+00

HL =    11.661      SBAR =    157.572
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ALT	N2 1/CC N 1/CC PRESSURE DYNES/CM**2	O2 1/CC NO 1/CC FEHSEQ	O 1/CC NO2 1/CC DENSITY GRAMS/CC	AR 1/CC O2(SDG) 1/CC DEN SC HT KM	HE 1/CC O3 1/CC TEMP DEG K	CO2 1/CC H2O 1/CC E TEMP DEG K	E 1/CC E 1/CC	O+ 1/CC O+ 1/CC	H+ 1/CC H+ 1/CC	QDFF 1/(CC SEC) N+ 1/CC
0,00	1,982E+19	5,362E+18	9,958E+02	2,287E+17	1,175E+15	8,132E+15	0,	0,	0,	1,815E+02
	9,799E-01	9,803E+09	2,619E+10	2,601E+06	8,000E+11	1,866E+17	0,	0,	0,	0,
	1,013E+06	-0,	1,222E-03	9,075E+00	2,888E+02	2,888E+02				
5,00	1,204E+19	3,258E+18	6,104E+03	1,390E+17	7,141E+14	4,941E+15	0,	0,	0,	9,307E+01
	9,799E-01	3,849E+09	6,902E+09	4,390E+06	5,700E+11	2,411E+16	0,	0,	0,	0,
	5,426E+05	-3,804E-05	7,425E-04	9,617E+00	2,545E+02	2,545E+02				
10,00	6,638E+18	1,796E+18	2,525E+04	7,659E+16	3,936E+14	2,723E+15	0,	0,	0,	4,773E+01
	9,799E-01	9,985E+08	1,783E+09	2,726E+07	1,100E+12	3,976E+14	0,	0,	0,	0,
	2,654E+05	-1,205E-04	4,092E-04	7,453E+00	2,259E+02	2,259E+02				
15,00	3,209E+18	8,680E+17	1,479E+05	3,702E+16	1,903E+14	1,316E+15	0,	0,	0,	2,447E+01
	9,799E-01	6,648E+08	1,259E+09	1,221E+08	2,500E+12	2,065E+13	0,	0,	0,	0,
	1,222E+05	-2,416E-04	1,978E-04	6,488E+00	2,151E+02	2,151E+02				
20,00	1,453E+18	3,931E+17	1,090E+06	1,677E+16	8,616E+13	5,961E+14	0,	0,	0,	1,255E+01
	9,799E-01	8,869E+08	1,772E+09	5,089E+08	4,800E+12	4,511E+12	0,	0,	0,	0,
	5,538E+04	-4,104E-04	8,958E-05	6,212E+00	2,153E+02	2,153E+02				
25,00	6,500E+17	1,758E+17	7,822E+06	7,500E+15	3,854E+13	2,667E+14	0,	0,	0,	6,435E+00
	9,799E-01	1,398E+09	2,597E+09	1,198E+09	4,300E+12	2,250E+12	0,	0,	0,	0,
	2,544E+04	-6,353E-04	4,007E-05	6,253E+00	2,211E+02	2,211E+02				
30,00	2,952E+17	7,986E+16	4,709E+07	3,406E+15	1,750E+13	1,211E+14	0,	0,	0,	3,300E+00
	9,799E-01	1,851E+09	2,416E+09	2,790E+09	2,500E+12	1,406E+12	0,	0,	0,	0,
	1,200E+04	-9,232E-04	1,820E-05	6,434E+00	2,297E+02	2,297E+02				
35,00	1,377E+17	3,724E+16	2,295E+08	1,588E+15	8,163E+12	5,648E+13	0,	0,	0,	1,692E+00
	9,799E-01	1,846E+09	1,176E+09	8,843E+09	1,400E+12	8,036E+11	0,	0,	0,	0,
	5,843E+03	-1,281E-03	8,487E-06	6,686E+00	2,398E+02	2,398E+02				
40,00	6,626E+16	1,793E+16	9,113E+08	7,646E+14	3,929E+12	2,719E+13	0,	0,	0,	8,677E-01
	9,799E-01	1,424E+09	3,225E+08	1,811E+10	6,100E+11	3,957E+11	0,	0,	0,	0,
	2,937E+03	-1,711E-03	4,085E-06	7,005E+00	2,504E+02	2,504E+02				
45,00	3,307E+16	8,946E+15	2,928E+09	3,816E+14	1,961E+12	1,357E+13	0,	0,	0,	4,450E-01
	1,111E+01	9,057E+08	6,280E+07	2,696E+10	1,823E+11	1,797E+11	0,	0,	0,	0,
	1,520E+03	-2,205E-03	2,039E-06	7,399E+00	2,596E+02	2,596E+02				
50,00	1,715E+16	4,640E+15	7,399E+09	1,979E+14	1,017E+12	7,037E+12	0,	0,	0,	2,282E-01
	8,627E+01	5,025E+08	1,134E+07	3,500E+10	5,450E+10	8,158E+10	0,	0,	0,	0,
	8,015E+02	-2,724E-03	1,057E-06	7,837E+00	2,640E+02	2,640E+02				
55,00	9,198E+15	2,488E+15	1,436E+10	1,061E+14	5,454E+11	3,773E+12	0,	0,	0,	1,170E-01
	4,865E+02	2,551E+08	2,355E+06	2,155E+10	1,629E+10	3,848E+10	0,	0,	0,	0,
	4,239E+02	-3,204E-03	5,671E-07	8,178E+00	2,604E+02	2,604E+02				
56,00	8,141E+15	2,202E+15	1,589E+10	9,394E+13	4,827E+11	3,340E+12	0,	0,	0,	1,024E-01
	6,648E+02	2,215E+08	1,770E+06	1,956E+10	1,279E+10	3,326E+10	0,	0,	0,	0,
	3,726E+02	-3,290E-03	5,019E-07	8,215E+00	2,585E+02	2,585E+02				
57,00	7,210E+15	1,950E+15	1,741E+10	8,319E+13	4,275E+11	2,958E+12	0,	0,	0,	8,958E-02
	8,991E+02	1,921E+08	1,346E+06	1,775E+10	1,005E+10	2,877E+10	0,	0,	0,	0,
	3,272E+02	-3,371E-03	4,445E-07	8,236E+00	2,564E+02	2,564E+02				
58,00	6,386E+15	1,727E+15	1,889E+10	7,368E+13	3,786E+11	2,620E+12	0,	0,	0,	7,837E-02
	1,204E+03	1,667E+08	1,034E+06	1,611E+10	7,892E+09	2,490E+10	0,	0,	0,	0,
	2,870E+02	-3,448E-03	3,937E-07	8,241E+00	2,539E+02	2,539E+02				
59,00	5,655E+15	1,530E+15	2,033E+10	6,526E+13	3,353E+11	2,320E+12	0,	0,	0,	6,857E-02
	1,596E+03	1,448E+08	8,043E+05	1,462E+10	6,199E+09	2,156E+10	0,	0,	0,	0,
	2,514E+02	-3,520E-03	3,487E-07	8,228E+00	2,512E+02	2,512E+02				

60.00	5,007E+15	1,354E+15	2,170E+10	5,777E+13	2,969E+11	2,054E+12	0.	0.	0.	6,000E-02
	2,098E+03	1,259E+08	6,325E+05	1,327E+10	4,868E+09	1,867E+10	0.	0.	0.	0.
	2,200E+02	-3,588E-03	3,087E-07	8,196E+00	2,482E+02	2,482E+02				
61.00	4,430E+15	1,198E+15	2,299E+10	5,112E+13	2,627E+11	1,818E+12	0.	0.	0.	7,723E-02
	2,731E+03	1,098E+08	5,031E+05	1,205E+10	3,824E+09	1,617E+10	0.	0.	0.	0.
	1,921E+02	-3,651E-03	2,732E-07	8,147E+00	2,450E+02	2,450E+02				
62.00	3,917E+15	1,060E+15	2,421E+10	4,519E+13	2,322E+11	1,607E+12	0.	0.	0.	9,940E-02
	3,526E+03	9,602E+07	4,045E+05	1,093E+10	3,003E+09	1,399E+10	0.	0.	0.	0.
	1,675E+02	-3,711E-03	2,415E-07	8,080E+00	2,416E+02	2,416E+02				
63.00	3,459E+15	9,356E+14	2,534E+10	3,991E+13	2,051E+11	1,419E+12	0.	0.	0.	1,279E-01
	4,515E+03	8,431E+07	3,287E+05	9,923E+09	2,359E+09	1,209E+10	0.	0.	0.	0.
	1,457E+02	-3,766E-03	2,132E-07	7,996E+00	2,380E+02	2,380E+02				
64.00	3,050E+15	8,250E+14	2,642E+10	3,519E+13	1,808E+11	1,251E+12	0.	0.	0.	1,647E-01
	5,735E+03	7,438E+07	2,697E+05	9,006E+09	1,853E+09	1,044E+10	0.	0.	0.	0.
	1,265E+02	-3,818E-03	1,880E-07	7,897E+00	2,344E+02	2,344E+02				
65.00	2,685E+15	7,262E+14	2,745E+10	3,098E+13	1,592E+11	1,101E+12	0.	0.	0.	2,120E-01
	7,229E+03	6,600E+07	2,235E+05	8,174E+09	1,455E+09	8,999E+09	0.	0.	0.	0.
	1,096E+02	-3,868E-03	1,655E-07	7,785E+00	2,307E+02	2,307E+02				
66.00	2,359E+15	6,380E+14	2,845E+10	2,721E+13	1,399E+11	9,676E+11	0.	0.	0.	2,728E-01
	9,044E+03	5,894E+07	1,868E+05	7,419E+09	1,143E+09	7,743E+09	0.	0.	0.	0.
	9,475E+01	-3,915E-03	1,454E-07	7,662E+00	2,270E+02	2,270E+02				
67.00	2,068E+15	5,593E+14	2,946E+10	2,386E+13	1,226E+11	8,483E+11	0.	0.	0.	3,512E-01
	1,124E+04	5,302E+07	1,574E+05	6,733E+09	8,977E+08	6,649E+09	0.	0.	0.	0.
	8,172E+01	-3,960E-03	1,275E-07	7,530E+00	2,233E+02	2,233E+02				
68.00	1,808E+15	4,892E+14	3,050E+10	2,087E+13	1,072E+11	7,419E+11	0.	0.	0.	4,520E-01
	1,386E+04	4,807E+07	1,336E+05	6,111E+09	7,051E+08	5,696E+09	0.	0.	0.	0.
	7,030E+01	-4,004E-03	1,115E-07	7,393E+00	2,196E+02	2,196E+02				
69.00	1,578E+15	4,267E+14	3,162E+10	1,820E+13	9,354E+10	6,472E+11	0.	0.	0.	5,818E-01
	1,699E+04	4,397E+07	1,141E+05	5,546E+09	5,538E+08	4,867E+09	0.	0.	0.	0.
	6,034E+01	-4,048E-03	9,726E-08	7,251E+00	2,161E+02	2,161E+02				
70.00	1,372E+15	3,712E+14	3,285E+10	1,584E+13	8,138E+10	5,630E+11	0.	0.	0.	7,488E-01
	2,069E+04	4,059E+07	9,808E+04	5,034E+09	4,349E+08	4,146E+09	0.	0.	0.	0.
	5,166E+01	-4,091E-03	8,461E-08	7,108E+00	2,127E+02	2,127E+02				
71.00	1,191E+15	3,220E+14	3,423E+10	1,374E+13	7,059E+10	4,884E+11	0.	0.	0.	9,638E-01
	2,504E+04	3,784E+07	8,471E+04	4,569E+09	3,416E+08	3,521E+09	0.	0.	0.	0.
	4,412E+01	-4,135E-03	7,340E-08	6,965E+00	2,094E+02	2,094E+02				
72.00	1,030E+15	2,786E+14	3,583E+10	1,188E+13	6,106E+10	4,225E+11	0.	0.	0.	1,241E+00
	3,013E+04	3,563E+07	7,348E+04	4,147E+09	2,683E+08	2,980E+09	0.	0.	0.	0.
	3,760E+01	-4,181E-03	6,349E-08	6,824E+00	2,063E+02	2,063E+02				
73.00	8,881E+14	2,402E+14	3,770E+10	1,025E+13	5,266E+10	3,644E+11	0.	0.	0.	1,597E+00
	3,605E+04	3,390E+07	6,397E+04	3,763E+09	2,107E+08	2,512E+09	0.	0.	0.	0.
	3,196E+01	-4,228E-03	5,475E-08	6,687E+00	2,033E+02	2,033E+02				
74.00	7,636E+14	2,065E+14	3,990E+10	8,811E+12	4,528E+10	3,133E+11	0.	0.	0.	2,055E+00
	4,289E+04	3,260E+07	5,584E+04	3,416E+09	1,655E+08	2,110E+09	0.	0.	0.	0.
	2,711E+01	-4,278E-03	4,708E-08	6,556E+00	2,006E+02	2,006E+02				
75.00	6,546E+14	1,771E+14	4,250E+10	7,553E+12	3,881E+10	2,686E+11	0.	0.	0.	2,645E+00
	5,077E+04	3,168E+07	4,885E+04	3,100E+09	1,300E+08	1,764E+09	0.	0.	0.	0.
	2,295E+01	-4,330E-03	4,036E-08	6,430E+00	1,981E+02	1,981E+02				
76.00	5,595E+14	1,513E+14	4,558E+10	6,456E+12	3,317E+10	2,295E+11	0.	0.	0.	3,405E+00
	5,979E+04	3,111E+07	4,281E+04	2,719E+09	1,012E+08	1,467E+09	0.	0.	0.	0.
	1,939E+01	-4,386E-03	3,449E-08	6,311E+00	1,957E+02	1,957E+02				
77.00	4,768E+14	1,290E+14	4,924E+10	5,502E+12	2,827E+10	1,956E+11	0.	0.	0.	4,383E+00
	7,007E+04	3,087E+07	3,755E+04	2,343E+09	8,090E+07	1,214E+09	0.	0.	0.	0.
	1,635E+01	-4,447E-03	2,940E-08	6,200E+00	1,937E+02	1,937E+02				
78.00	4,052E+14	1,096E+14	5,359E+10	4,676E+12	2,403E+10	1,662E+11	0.	0.	0.	5,641E+00
	8,173E+04	3,093E+07	3,296E+04	2,094E+09	6,961E+07	9,991E+08	0.	0.	0.	0.
	1,376E+01	-4,511E-03	2,498E-08	6,096E+00	1,918E+02	1,918E+02				
79.00	3,435E+14	9,289E+13	5,876E+10	3,963E+12	2,037E+10	1,409E+11	0.	0.	0.	7,261E+00
	9,490E+04	3,128E+07	2,893E+04	1,997E+09	6,574E+07	8,169E+08	0.	0.	0.	0.
	1,157E+01	-4,581E-03	2,118E-08	6,002E+00	1,902E+02	1,902E+02				

80.00	2.904E+14	7.853E+13	6.489E+10	3.351E+12	1.722E+10	1.191E+11	0.	0.	0.	9.345E+00
	1.097E+05	3.191E+07	2.539E+04	2.050E+09	6.800E+07	6.633E+08	0.	0.	0.	0.
	9.710E+00	-4.656E-03	1.790E-08	5.916E+00	1.889E+02	1.889E+02				
81.00	2.450E+14	6.623E+13	7.213E+10	2.826E+12	1.452E+10	1.005E+11	0.	0.	0.	1.203E+01
	1.263E+05	3.281E+07	2.227E+04	2.243E+09	7.563E+07	5.345E+08	0.	0.	0.	0.
	8.143E+00	-4.737E-03	1.510E-08	5.838E+00	1.878E+02	1.878E+02				
82.00	2.062E+14	5.573E+13	8.067E+10	2.379E+12	1.223E+10	8.459E+10	0.	0.	0.	1.548E+01
	1.449E+05	3.397E+07	1.952E+04	2.560E+09	8.771E+07	4.273E+08	0.	0.	0.	0.
	6.822E+00	-4.824E-03	1.271E-08	5.770E+00	1.869E+02	1.869E+02				
83.00	1.732E+14	4.681E+13	9.070E+10	1.999E+12	1.027E+10	7.106E+10	0.	0.	0.	1.993E+01
	1.654E+05	3.538E+07	1.710E+04	2.961E+09	1.022E+08	3.385E+08	0.	0.	0.	0.
	5.713E+00	-4.918E-03	1.068E-08	5.710E+00	1.863E+02	1.863E+02				
84.00	1.453E+14	3.925E+13	1.024E+11	1.676E+12	8.614E+09	5.960E+10	0.	0.	0.	2.565E+01
	1.882E+05	3.702E+07	1.496E+04	3.353E+09	1.148E+08	2.656E+08	0.	0.	0.	0.
	4.782E+00	-5.019E-03	8.956E-09	5.659E+00	1.859E+02	1.859E+02				
85.00	1.217E+14	3.285E+13	1.160E+11	1.404E+12	7.213E+09	4.991E+10	0.	0.	0.	3.302E+01
	2.133E+05	3.889E+07	1.308E+04	3.600E+09	1.200E+08	2.063E+08	0.	0.	0.	0.
	4.002E+00	-5.127E-03	7.500E-09	5.616E+00	1.858E+02	1.858E+02				
86.00	1.018E+14	2.746E+13	1.317E+11	1.174E+12	6.033E+09	4.174E+10	0.	0.	0.	4.249E+01
	2.410E+05	4.095E+07	1.142E+04	3.562E+09	1.132E+08	1.585E+08	0.	0.	0.	0.
	3.349E+00	-5.243E-03	6.273E-09	5.582E+00	1.859E+02	1.859E+02				
87.00	8.503E+13	2.293E+13	1.496E+11	9.811E+11	5.042E+09	3.488E+10	0.	0.	0.	5.470E+01
	2.713E+05	4.318E+07	9.972E+03	3.187E+09	9.464E+07	1.203E+08	0.	0.	0.	0.
	2.804E+00	-5.367E-03	5.242E-09	5.556E+00	1.862E+02	1.862E+02				
88.00	7.100E+13	1.912E+13	1.697E+11	8.192E+11	4.210E+09	2.913E+10	0.	0.	0.	7.040E+01
	3.045E+05	4.553E+07	8.699E+03	2.565E+09	7.014E+07	9.023E+07	0.	0.	0.	0.
	2.349E+00	-5.500E-03	4.377E-09	5.538E+00	1.867E+02	1.867E+02				
89.00	5.926E+13	1.593E+13	1.921E+11	6.837E+11	3.514E+09	2.431E+10	0.	0.	0.	9.062E+01
	3.406E+05	4.796E+07	7.587E+03	1.881E+09	4.706E+07	6.681E+07	0.	0.	0.	0.
	1.969E+00	-5.641E-03	3.653E-09	5.528E+00	1.875E+02	1.875E+02				
90.00	4.945E+13	1.327E+13	2.166E+11	5.706E+11	2.932E+09	2.029E+10	1.353E+04	4.245E-04	1.353E+04	1.166E+02
	3.798E+05	5.040E+07	6.616E+03	1.300E+09	3.000E+07	4.881E+07	1.353E+04	4.245E-04	1.353E+04	4.335E-11
	1.652E+00	-5.792E-03	3.049E-09	5.525E+00	1.884E+02	1.884E+02				
95.00	2.010E+13	5.262E+12	3.521E+11	2.320E+11	1.192E+09	8.248E+09	3.679E+04	3.155E-02	3.679E+04	8.295E+02
	6.277E+05	6.051E+07	3.368E+03	1.937E+08	3.128E+06	8.310E+06	3.679E+04	3.155E-02	3.679E+04	2.964E-09
	7.015E-01	-6.689E-03	1.239E-09	5.613E+00	1.958E+02	1.958E+02				
100.00	8.381E+12	2.056E+12	4.225E+11	9.670E+10	4.969E+08	3.438E+09	1.000E+05	1.691E+00	1.000E+05	5.810E+03
	9.733E+05	6.204E+07	1.793E+03	2.886E+07	3.261E+05	1.075E+06	1.000E+05	1.691E+00	1.000E+05	1.690E-07
	3.124E-01	-7.863E-03	5.167E-10	5.834E+00	2.066E+02	2.066E+02				
101.00	7.066E+12	1.702E+12	4.191E+11	8.153E+10	4.190E+08	2.875E+09	1.020E+05	2.486E+00	1.020E+05	5.964E+03
	1.055E+06	6.115E+07	1.594E+03	1.972E+07	2.075E+05	7.031E+05	1.020E+05	2.486E+00	1.020E+05	2.584E-07
	2.676E-01	-8.139E-03	4.356E-10	5.889E+00	2.092E+02	2.092E+02				
102.00	5.967E+12	1.409E+12	4.097E+11	6.885E+10	3.538E+08	2.377E+09	1.039E+05	3.592E+00	1.039E+05	6.117E+03
	1.141E+06	5.993E+07	1.421E+03	1.348E+07	1.320E+05	4.605E+05	1.039E+05	3.592E+00	1.039E+05	3.924E-07
	2.299E-01	-8.431E-03	3.679E-10	5.945E+00	2.120E+02	2.120E+02				
103.00	5.047E+12	1.168E+12	3.947E+11	5.824E+10	2.993E+08	1.950E+09	1.060E+05	5.098E+00	1.060E+05	6.265E+03
	1.232E+06	5.845E+07	1.272E+03	9.209E+06	8.399E+04	3.028E+05	1.060E+05	5.098E+00	1.060E+05	5.921E-07
	1.980E-01	-8.742E-03	3.112E-10	6.002E+00	2.151E+02	2.151E+02				
104.00	4.276E+12	9.693E+11	3.750E+11	4.934E+10	2.536E+08	1.593E+09	1.080E+05	7.112E+00	1.080E+05	6.408E+03
	1.327E+06	5.677E+07	1.142E+03	6.293E+06	5.344E+04	2.007E+05	1.080E+05	7.112E+00	1.080E+05	8.879E-07
	1.710E-01	-9.075E-03	2.636E-10	6.061E+00	2.185E+02	2.185E+02				
105.00	3.629E+12	8.058E+11	3.517E+11	4.187E+10	2.152E+08	1.300E+09	1.101E+05	9.756E+00	1.101E+05	6.543E+03
	1.427E+06	5.493E+07	1.029E+03	4.300E+06	3.400E+04	1.346E+05	1.101E+05	9.756E+00	1.101E+05	1.324E-06
	1.481E-01	-9.431E-03	2.237E-10	6.119E+00	2.223E+02	2.223E+02				

106,00	3,084E+12	6,713E+11	3,259E+11	3,558E+10	1,829E+08	1,062E+09	1,122E+05	1,317E+01	1,122E+05	6,667E+03
	1,531E+06	5,299E+07	9,301E+02	2,938E+06	2,163E+04	9,165E+04	1,122E+05	1,317E+01	1,122E+05	1,963E-06
	1,287E-01	-9,816E-03	1,901E-10	6,177E+00	2,265E+02	2,265E+02				
107,00	2,625E+12	5,607E+11	2,988E+11	3,029E+10	1,556E+08	8,684E+08	1,143E+05	1,750E+01	1,143E+05	6,778E+03
	1,640E+06	5,100E+07	8,435E+02	2,008E+06	1,376E+04	6,359E+04	1,143E+05	1,750E+01	1,143E+05	2,896E-06
	1,123E-01	-1,023E-02	1,618E-10	6,234E+00	2,313E+02	2,313E+02				
108,00	2,238E+12	4,696E+11	2,714E+11	2,582E+10	1,327E+08	7,119E+08	1,165E+05	2,292E+01	1,165E+05	6,874E+03
	1,753E+06	4,899E+07	7,675E+02	1,372E+06	8,757E+03	4,512E+04	1,165E+05	2,292E+01	1,165E+05	4,248E-06
	9,822E-02	-1,069E-02	1,379E-10	6,290E+00	2,368E+02	2,368E+02				
109,00	1,910E+12	3,945E+11	2,444E+11	2,204E+10	1,133E+08	5,845E+08	1,187E+05	2,963E+01	1,186E+05	6,952E+03
	1,870E+06	4,[illegible]00E+07	7,004E+02	9,376E+05	5,572E+03	3,283E+04	1,187E+05	2,963E+01	1,186E+05	6,197E-06
	8,626E-02	-1,119E-02	1,178E-10	6,347E+00	2,430E+02	2,430E+02				
110,00	1,633E+12	3,323E+11	2,187E+11	1,884E+10	9,681E+07	4,800E+08	1,209E+05	3,783E+01	1,209E+05	7,010E+03
	1,992E+06	4,504E+07	6,410E+02	6,407E+05	3,545E+03	2,457E+04	1,209E+05	3,783E+01	1,209E+05	8,989E-06
	7,605E-02	-1,174E-02	1,007E-10	6,404E+00	2,501E+02	2,501E+02				
111,00	1,398E+12	2,808E+11	1,946E+11	1,613E+10	8,287E+07	3,937E+08	1,231E+05	4,776E+01	1,231E+05	7,047E+03
	2,117E+06	4,311E+07	5,881E+02	4,378E+05	2,255E+03	1,893E+04	1,231E+05	4,776E+01	1,231E+05	1,296E-05
	6,732E-02	-1,234E-02	8,617E-11	6,468E+00	2,581E+02	2,581E+02				
112,00	1,198E+12	2,380E+11	1,724E+11	1,383E+10	7,105E+07	3,219E+08	1,254E+05	5,967E+01	1,254E+05	7,061E+03
	2,247E+06	4,124E+07	5,409E+02	2,992E+05	1,435E+03	1,502E+04	1,254E+05	5,967E+01	1,254E+05	1,856E-05
	5,986E-02	-1,302E-02	7,388E-11	6,542E+00	2,672E+02	2,672E+02				
113,00	1,029E+12	2,023E+11	1,522E+11	1,187E+10	6,102E+07	2,619E+08	1,277E+05	7,382E+01	1,277E+05	7,053E+03
	2,380E+06	3,941E+07	4,985E+02	2,044E+05	9,130E+02	1,225E+04	1,277E+05	7,382E+01	1,277E+05	2,640E-05
	5,345E-02	-1,376E-02	6,345E-11	6,626E+00	2,774E+02	2,774E+02				
114,00	8,858E+11	1,725E+11	1,341E+11	1,022E+10	5,252E+07	2,117E+08	1,301E+05	8,966E+01	1,300E+05	7,024E+03
	2,517E+06	3,763E+07	4,603E+02	1,397E+05	5,809E+02	1,025E+04	1,301E+05	8,966E+01	1,300E+05	3,726E-05
	4,796E-02	-1,458E-02	5,461E-11	6,721E+00	2,888E+02	2,888E+02				
115,00	7,644E+11	1,478E+11	1,180E+11	8,821E+09	4,533E+07	1,700E+08	1,324E+05	1,076E+02	1,323E+05	6,980E+03
	2,658E+06	3,592E+07	4,257E+02	9,546E+04	3,696E+02	8,734E+03	1,324E+05	1,076E+02	1,323E+05	5,215E-05
	4,323E-02	-1,548E-02	4,713E-11	6,826E+00	3,013E+02	3,013E+02				
116,00	6,623E+11	1,272E+11	1,038E+11	7,642E+09	3,927E+07	1,357E+08	1,348E+05	1,278E+02	1,347E+05	6,927E+03
	2,802E+06	3,430E+07	3,941E+02	6,523E+04	2,351E+02	7,517E+03	1,348E+05	1,278E+02	1,347E+05	7,233E-05
	3,914E-02	-1,644E-02	4,083E-11	6,941E+00	3,146E+02	3,146E+02				
117,00	5,769E+11	1,103E+11	9,144E+10	6,656E+09	3,420E+07	1,078E+08	1,373E+05	1,501E+02	1,371E+05	6,879E+03
	2,949E+06	3,281E+07	3,653E+02	4,457E+04	1,496E+02	6,452E+03	1,373E+05	1,501E+02	1,371E+05	9,928E-05
	3,560E-02	-1,745E-02	3,557E-11	7,067E+00	3,283E+02	3,283E+02				
118,00	5,064E+11	9,663E+10	8,071E+10	5,843E+09	3,003E+07	8,584E+07	1,397E+05	1,741E+02	1,396E+05	6,854E+03
	3,098E+06	3,152E+07	3,389E+02	3,046E+04	9,519E+01	5,429E+03	1,397E+05	1,741E+02	1,396E+05	1,346E-04
	3,250E-02	-1,844E-02	3,122E-11	7,202E+00	3,414E+02	3,414E+02				
119,00	4,494E+11	8,579E+10	7,156E+10	5,186E+09	2,665E+07	6,893E+07	1,422E+05	1,988E+02	1,420E+05	6,877E+03
	3,251E+06	3,052E+07	3,146E+02	2,081E+04	6,056E+01	4,382E+03	1,422E+05	1,988E+02	1,420E+05	1,800E-04
	2,978E-02	-1,934E-02	2,771E-11	7,349E+00	3,524E+02	3,524E+02				
119,99	4,053E+11	7,767E+10	6,397E+10	4,677E+09	2,404E+07	5,660E+07	1,447E+05	2,228E+02	1,445E+05	6,983E+03
	3,403E+06	2,998E+07	2,924E+02	1,428E+04	3,871E+01	3,310E+03	1,447E+05	2,228E+02	1,445E+05	2,359E-04
	2,737E-02	-2,001E-02	2,499E-11	7,503E+00	3,593E+02	3,593E+02				
120,00	4,050E+11	7,760E+10	6,390E+10	4,673E+09	2,401E+07	5,650E+07	1,447E+05	2,231E+02	1,445E+05	6,985E+03
	3,405E+06	2,998E+07	2,922E+02	1,422E+04	3,853E+01	3,299E+03	1,447E+05	2,230E+02	1,445E+05	2,365E-04
	2,735E-02	-9,028E-06	2,497E-11	7,505E+00	3,593E+02	3,593E+02				
121,00	3,556E+11	6,730E+10	5,823E+10	3,954E+09	2,311E+07	4,721E+07	1,473E+05	2,331E+02	1,471E+05	6,027E+03
	3,561E+06	2,897E+07	2,714E+02	9,719E+03	2,452E+01	2,794E+03	1,473E+05	2,331E+02	1,471E+05	2,730E-04
	2,514E-02	-9,748E-06	2,193E-11	7,888E+00	3,753E+02	4,312E+02				
122,00	3,141E+11	5,875E+10	5,330E+10	3,371E+09	2,228E+07	3,978E+07	1,499E+05	2,656E+02	1,496E+05	5,724E+03
	3,720E+06	2,811E+07	2,523E+02	6,641E+03	1,560E+01	2,367E+03	1,499E+05	2,656E+02	1,496E+05	3,419E-04
	2,319E-02	-1,048E-05	1,938E-11	8,269E+00	3,910E+02	4,700E+02				
123,00	2,790E+11	5,159E+10	4,899E+10	2,894E+09	2,152E+07	3,376E+07	1,525E+05	3,055E+02	1,522E+05	5,532E+03
	3,879E+06	2,738E+07	2,345E+02	4,538E+03	9,924E+00	2,005E+03	1,525E+05	3,055E+02	1,522E+05	4,306E-04
	2,147E-02	-1,123E-05	1,722E-11	8,650E+00	4,065E+02	5,033E+02				

124,00	2,490E+11	4,555E+10	4,520E+10	2,501E+09	2,082E+07	2,884E+07	1,551E+05	3,523E+02	1,548E+05	5,400E+03
	4,040E+06	2,677E+07	2,181E+02	3,101E+03	6,314E+00	1,698E+03	1,551E+05	3,522E+02	1,548E+05	5,414E-04
	1,993E-02	-1,199E-05	1,537E-11	9,029E+00	4,217E+02	5,335E+02				
125,00	2,233E+11	4,042E+10	4,184E+10	2,173E+09	2,017E+07	2,479E+07	1,578E+05	4,060E+02	1,574E+05	5,305E+03
	4,201E+06	2,629E+07	2,029E+02	2,119E+03	4,017E+00	1,438E+03	1,578E+05	4,059E+02	1,574E+05	6,779E-04
	1,856E-02	-1,275E-05	1,379E-11	9,407E+00	4,367E+02	5,617E+02				
130,00	1,370E+11	2,364E+10	2,965E+10	1,155E+09	1,755E+07	1,255E+07	1,716E+05	8,011E+02	1,708E+05	5,133E+03
	5,006E+06	2,422E+07	1,438E+02	3,158E+02	4,189E-01	6,273E+02	1,716E+05	8,010E+02	1,708E+05	1,930E-03
	1,344E-02	-1,673E-05	8,496E-12	1,128E+01	5,084E+02	6,852E+02				
135,00	9,041E+10	1,496E+10	2,218E+10	6,728E+08	1,563E+07	7,007E+06	1,862E+05	1,487E+03	1,847E+05	5,213E+03
	5,779E+06	2,231E+07	1,081E+02	4,705E+01	4,367E-02	2,735E+02	1,862E+05	1,487E+03	1,847E+05	4,834E-03
	1,018E-02	-2,087E-05	5,635E-12	1,312E+01	5,749E+02	7,914E+02				
140,00	6,287E+10	1,003E+10	1,726E+10	4,185E+08	1,417E+07	4,197E+06	2,015E+05	2,512E+03	1,990E+05	5,426E+03
	6,480E+06	2,056E+07	8,997E+01	7,010E+00	4,553E-03	1,193E+02	2,015E+05	2,512E+03	1,990E+05	1,087E-02
	7,962E-03	-2,511E-05	3,944E-12	1,493E+01	6,366E+02	8,866E+02				
145,00	4,548E+10	7,012E+09	1,382E+10	2,737E+08	1,301E+07	2,651E+06	2,175E+05	4,046E+03	2,135E+05	5,725E+03
	7,081E+06	1,894E+07	8,210E+01	1,044E+00	4,747E-04	5,201E+01	2,175E+05	4,044E+03	2,135E+05	2,231E-02
	6,381E-03	-2,938E-05	2,874E-12	1,670E+01	6,939E+02	9,734E+02				
150,00	3,394E+10	5,072E+09	1,133E+10	1,860E+08	1,206E+07	1,746E+06	2,343E+05	6,262E+03	2,280E+05	6,087E+03
	7,564E+06	1,745E+07	7,403E+01	1,556E-01	4,949E-05	2,268E+01	2,343E+05	6,259E+03	2,280E+05	4,248E-02
	5,212E-03	-3,366E-05	2,162E-12	1,844E+01	7,470E+02	1,053E+03				
160,00	2,026E+10	2,862E+09	8,017E+09	9,379E+07	1,061E+07	8,310E+05	2,698E+05	1,364E+04	2,561E+05	6,936E+03
	8,177E+06	1,482E+07	4,638E+01	3,455E-03	5,380E-07	4,312E+00	2,698E+05	1,363E+04	2,561E+05	1,282E-01
	3,632E-[illegible]	-4,207E-05	1,314E-12	2,179E+01	8,419E+02	1,195E+03				
170,00	1,294E+10	1,738E+09	5,965E+09	5,149E+07	9,535E+06	4,334E+05	3,076E+05	2,681E+04	2,808E+05	7,860E+03
	8,410E+06	1,258E+07	3,330E+01	7,669E-05	5,848E-09	8,198E-01	3,076E+05	2,678E+04	2,808E+05	3,209E-01
	2,641E-03	-5,015E-05	8,563E-13	2,498E+01	9,237E+02	1,319E+03				
180,00	8,678E+09	1,112E+09	4,600E+09	3,005E+07	8,708E+06	2,412E+05	3,474E+05	4,836E+04	2,991E+05	8,736E+03
	8,417E+06	1,068E+07	2,391E+01	1,703E-06	6,357E-11	1,559E-01	3,474E+05	4,831E+04	2,991E+05	6,972E-01
	1,981E-03	-5,775E-05	5,870E-13	2,802E+01	9,942E+02	1,427E+03				
190,00	6,032E+09	7,404E+08	3,643E+09	1,834E+07	8,046E+06	1,409E+05	3,886E+05	8,077E+04	3,078E+05	9,425E+03
	8,314E+06	9,064E+06	1,717E+01	3,780E-08	6,910E-13	2,964E-02	3,885E+05	8,064E+04	3,078E+05	1,352E+00
	1,521E-03	-6,482E-05	4,180E-13	3,089E+01	1,055E+03	1,523E+03				
200,00	4,310E+09	5,079E+08	2,945E+09	1,160E+07	7,501E+06	8,543E+04	4,304E+05	1,254E+05	3,049E+05	9,797E+03
	8,121E+06	7,694E+06	1,233E+01	8,391E-10	7,512E-15	5,636E-03	4,302E+05	1,252E+05	3,050E+05	2,368E+00
	1,190E-03	-7,129E-05	3,065E-13	3,362E+01	1,107E+03	1,607E+03				
220,00	2,339E+09	2,553E+08	2,013E+09	5,004E+06	6,647E+06	3,410E+04	5,127E+05	2,472E+05	2,655E+05	9,332E+03
	7,300E+06	5,545E+06	6,354E+00	4,135E-13	8,876E-19	2,037E-04	5,123E+05	2,466E+05	2,657E+05	5,348E+00
	7,599E-04	-8,239E-05	1,762E-13	3,865E+01	1,192E+03	1,751E+03				
240,00	1,344E+09	1,366E+08	1,435E+09	2,321E+06	5,998E+06	1,470E+04	5,875E+05	3,869E+05	2,006E+05	7,577E+03
	5,205E+06	3,996E+06	3,276E+00	2,038E-16	1,049E-22	7,366E-06	5,867E+05	3,858E+05	2,009E+05	7,291E+00
	5,063E-04	-9,104E-05	1,081E-13	4,319E+01	1,255E+03	1,867E+03				
260,00	8,028E+08	7,621E+07	1,052E+09	1,131E+06	5,480E+06	6,684E+03	6,476E+05	5,101E+05	1,374E+05	5,442E+03
	3,110E+06	2,880E+06	1,689E+00	1,004E-19	1,239E-26	2,663E-07	6,463E+05	5,086E+05	1,377E+05	6,804E+00
	3,482E-04	-9,735E-05	6,946E-14	4,731E+01	1,301E+03	1,963E+03				
280,00	4,931E+08	4,384E+07	7,876E+08	5,708E+05	5,049E+06	3,155E+03	6,865E+05	5,973E+05	8,925E+04	3,598E+03
	1,910E+06	2,075E+06	8,705E-01	4,950E-23	1,464E-30	9,627E-09	6,849E+05	5,955E+05	8,946E+04	5,666E+00
	2,455E-04	-1,015E-04	4,626E-14	5,110E+01	1,337E+03	2,044E+03				
300,00	3,091E+08	2,578E+07	5,981E+08	2,956E+05	4,681E+06	1,532E+03	7,000E+05	6,434E+05	5,662E+04	2,251E+03
	1,197E+06	1,496E+06	4,488E-01	2,439E-26	1,730E-34	3,481E-10	6,980E+05	6,413E+05	5,678E+04	4,354E+00
	1,765E-04	-1,037E-04	3,169E-14	5,461E+01	1,363E+03	2,113E+03				
320,00	1,967E+08	1,542E+07	4,592E+08	1,561E+05	4,360E+06	7,592E+02	6,334E+05	5,978E+05	3,555E+04	1,244E+03
	7,618E+05	1,078E+06	2,313E-01	1,202E-29	2,045E-38	1,258E-11	6,315E+05	5,959E+05	3,565E+04	2,892E+00
	1,290E-04	-1,042E-04	2,221E-14	5,790E+01	1,383E+03	2,173E+03				
340,00	1,266E+08	9,338E+06	3,555E+08	8,371E+04	4,074E+06	3,825E+02	5,731E+05	5,506E+05	2,246E+04	6,941E+02
	4,905E+05	7,767E+05	1,193E-01	5,925E-33	2,416E-42	4,549E-13	5,714E+05	5,489E+05	2,253E+04	1,908E+00
	9,563E-05	-1,033E-04	1,586E-14	6,100E+01	1,398E+03	2,227E+03				

360.00	8,229E+07	5,714E+06	2,770E+08	4,543E+04	3,817E+06	1,952E+02	5,186E+05	5,043E+05	1,431E+04	3,917E+02
	3,187E+05	5,597E+05	6,148E-02	2,920E-36	2,855E-46	1,645E-14	5,170E+05	5,027E+05	1,435E+04	1,255E+00
	7,174E-05	-1,011E-04	1,152E-14	6,394E+01	1,409E+03	2,275E+03				
380.00	5,387E+07	3,525E+06	2,169E+08	2,489E+04	3,583E+06	1,007E+02	4,692E+05	4,600E+05	9,191E+03	2,234E+02
	2,087E+05	4,034E+05	3,169E-02	1,439E-39	3,373E-50	5,946E-16	4,679E+05	4,586E+05	9,218E+03	8,239E-01
	5,437E-05	-9,792E-05	8,481E-15	6,672E+01	1,417E+03	2,319E+03				
400.00	3,548E+07	2,189E+06	1,705E+08	1,375E+04	3,368E+06	5,238E+01	4,246E+05	4,186E+05	5,953E+03	1,287E+02
	1,374E+05	2,907E+05	1,634E-02	7,092E-43	3,986E-54	2,150E-17	4,234E+05	4,174E+05	5,970E+03	5,409E-01
	4,159E-05	-9,401E-05	6,321E-15	6,936E+01	1,424E+03	2,359E+03				
420.00	2,349E+07	1,367E+06	1,346E+08	7,648E+03	3,171E+06	2,746E+01	3,842E+05	3,803E+05	3,888E+03	7,492E+01
	9,100E+04	2,095E+05	8,423E-03	3,495E-46	4,710E-58	7,772E-19	3,831E+05	3,792E+05	3,899E+03	3,553E-01
	3,207E-05	-8,955E-05	4,762E-15	7,186E+01	1,428E+03	2,397E+03				
440.00	1,562E+07	8,584E+05	1,065E+08	4,279E+03	2,988E+06	1,449E+01	3,476E+05	3,451E+05	2,559E+03	4,400E+01
	6,052E+04	1,510E+05	4,342E-03	1,723E-49	5,565E-62	2,810E-20	3,467E+05	3,442E+05	2,566E+03	2,337E-01
	2,490E-05	-8,473E-05	3,621E-15	7,421E+01	1,432E+03	2,432E+03				
460.00	1,043E+07	5,412E+05	8,446E+07	2,407E+03	2,817E+06	7,687E+00	3,145E+05	3,128E+05	1,697E+03	2,607E+01
	4,040E+04	1,088E+05	2,238E-03	8,490E-53	6,576E-66	1,016E-21	3,138E+05	3,121E+05	1,701E+03	1,540E-01
	1,947E-05	-7,970E-05	2,777E-15	7,642E+01	1,435E+03	2,466E+03				
480.00	6,988E+06	3,426E+05	6,715E+07	1,361E+03	2,659E+06	4,101E+00	2,846E+05	2,835E+05	1,133E+03	1,556E+01
	2,707E+04	7,840E+04	1,154E-03	4,184E-56	7,770E-70	3,672E-23	2,840E+05	2,828E+05	1,135E+03	1,017E-01
	1,530E-05	-7,458E-05	2,145E-15	7,851E+01	1,437E+03	2,498E+03				
500.00	4,697E+06	2,176E+05	5,349E+07	7,724E+02	2,511E+06	2,198E+00	2,575E+05	2,568E+05	7,609E+02	9,359E+00
	1,819E+04	5,650E+04	5,949E-04	2,062E-59	9,181E-74	1,328E-24	2,570E+05	2,562E+05	7,625E+02	6,734E-02
	1,210E-05	-6,949E-05	1,668E-15	8,046E+01	1,439E+03	2,528E+03				
520.00	3,166E+06	1,387E+05	4,269E+07	4,403E+02	2,372E+06	1,183E+00	2,330E+05	2,325E+05	5,140E+02	5,667E+00
	1,226E+04	4,072E+04	3,067E-04	1,016E-62	1,085E-77	4,800E-26	2,326E+05	2,321E+05	5,150E+02	4,470E-02
	9,615E-06	-6,450E-05	1,304E-15	8,231E+01	1,440E+03	2,558E+03				
540.00	2,140E+06	8,870E+04	3,412E+07	2,520E+02	2,243E+06	6,399E-01	2,108E+05	2,105E+05	3,491E+02	3,454E+00
	8,289E+03	2,934E+04	1,581E-04	5,008E-66	1,282E-81	1,735E-27	2,105E+05	2,101E+05	3,497E+02	2,976E-02
	7,677E-06	-5,967E-05	1,026E-15	8,405E+01	1,441E+03	2,587E+03				
560.00	1,450E+06	5,688E+04	2,732E+07	1,447E+02	2,121E+06	3,474E-01	1,908E+05	1,905E+05	2,382E+02	2,117E+00
	5,618E+03	2,115E+04	8,149E-05	2,468E-69	1,515E-85	6,273E-29	1,905E+05	1,903E+05	2,386E+02	1,987E-02
	6,159E-06	-5,505E-05	8,104E-16	8,569E+01	1,442E+03	2,614E+03				
580.00	9,855E+05	3,658E+04	2,190E+07	8,341E+01	2,007E+06	1,893E-01	1,726E+05	1,725E+05	1,632E+02	1,306E+00
	3,817E+03	1,524E+04	4,201E-05	1,216E-72	1,790E-89	2,268E-30	1,724E+05	1,722E+05	1,635E+02	1,332E-02
	4,964E-06	-5,066E-05	6,431E-16	8,727E+01	1,442E+03	2,641E+03				
600.00	6,712E+05	2,359E+04	1,759E+07	4,825E+01	1,899E+06	1,036E-01	1,562E+05	1,561E+05	1,123E+02	8,101E-01
	2,600E+03	1,098E+04	2,166E-05	5,995E-76	2,115E-93	8,199E-32	1,560E+05	1,559E+05	1,125E+02	8,958E-03
	4,020E-06	-4,652E-05	5,124E-16	8,879E+01	1,443E+03	2,667E+03				
620.00	4,583E+05	1,526E+04	1,414E+07	2,800E+01	1,798E+06	5,688E-02	1,413E+05	1,412E+05	7,757E+01	5,055E-01
	1,775E+03	7,914E+03	1,116E-05	2,955E-79	2,499E-97	2,964E-33	1,412E+05	1,411E+05	7,766E+01	6,049E-03
	3,270E-06	-4,263E-05	4,098E-16	9,027E+01	1,443E+03	2,693E+03				
640.00	3,136E+05	9,892E+03	1,139E+07	1,630E+01	1,703E+06	3,134E-02	1,279E+05	1,278E+05	5,375E+01	3,173E-01
	1,215E+03	5,703E+03	5,755E-06	1,456E-82	2,953-101	1,072E-34	1,278E+05	1,277E+05	5,381E+01	4,102E-03
	2,672E-06	-3,900E-05	3,289E-16	9,173E+01	1,443E+03	2,718E+03				
660.00	2,151E+05	6,430E+03	9,180E+06	9,521E+00	1,614E+06	1,733E-02	1,157E+05	1,157E+05	3,737E+01	2,004E-01
	8,331E+02	4,110E+03	2,967E-06	7,176E-86	3,489-105	3,874E-36	1,156E+05	1,156E+05	3,740E+01	2,794E-03
	2,195E-06	-3,562E-05	2,649E-16	9,318E+01	1,443E+03	2,742E+03				
680.00	1,478E+05	4,190E+03	7,410E+06	5,579E+00	1,530E+06	9,619E-03	1,047E+05	1,047E+05	2,605E+01	1,275E-01
	5,726E+02	2,962E+03	1,530E-06	3,537E-89	4,123-109	1,401E-37	1,046E+05	1,046E+05	2,608E+01	1,913E-03
	1,812E-06	-3,247E-05	2,141E-16	9,466E+01	1,443E+03	2,766E+03				
700.00	1,018E+05	2,738E+03	5,989E+06	3,279E+00	1,450E+06	5,356E-03	9,473E+04	9,472E+04	1,822E+01	8,166E-02
	3,945E+02	2,134E+03	7,885E-07	1,743E-92	4,872-113	5,064E-39	9,469E+04	9,467E+04	1,823E+01	1,317E-03
	1,504E-06	-2,956E-05	1,736E-16	9,617E+01	1,444E+03	2,790E+03				
720.00	7,030E+04	1,793E+03	4,847E+06	1,933E+00	1,375E+06	2,993E-03	8,572E+04	8,571E+04	1,277E+01	5,274E-02
	2,723E+02	1,538E+03	4,065E-07	8,590E-96	5,756-117	1,831E-40	8,569E+04	8,568E+04	1,278E+01	9,117E-04
	1,255E-06	-2,687E-05	1,413E-16	9,774E+01	1,444E+03	2,813E+03				

740,00	4,864E+04	1,177E+03	3,927E+06	1,143E+00	1,305E+06	1,678E-03	7,756E+04	7,755E+04	8,975E+00	3,438E-02
	1,884E+02	1,108E+03	2,095E-07	4,233E-99	6,802-121	6,619E-42	7,754E+04	7,754E+04	8,981E+00	6,356E-04
	1,053E-06	-2,438E-05	1,153E-16	9,940E+01	1,444E+03	2,836E+03				
760,00	3,372E+04	7,745E+02	3,185E+06	6,779E-01	1,238E+06	9,435E-04	7,018E+04	7,017E+04	6,322E+00	2,263E-02
	1,306E+02	7,988E+02	1,080E-07	2,086-102	8,037-125	2,393E-43	7,017E+04	7,017E+04	6,326E+00	4,465E-04
	8,887E-07	-2,209E-05	9,447E-17	1,012E+02	1,444E+03	2,858E+03				
780,00	2,342E+04	5,109E+02	2,587E+06	4,033E-01	1,175E+06	5,323E-04	6,350E+04	6,350E+04	4,464E+00	1,507E-02
	9,073E+01	5,757E+02	5,569E-08	1,028-105	9,497-129	8,651E-45	6,350E+04	6,350E+04	4,467E+00	3,164E-04
	7,548E-07	-1,997E-05	7,766E-17	1,030E+02	1,444E+03	2,880E+03				
800,00	1,631E+04	3,378E+02	2,104E+06	2,406E-01	1,116E+06	3,013E-04	5,746E+04	5,746E+04	3,159E+00	1,016E-02
	6,316E+01	4,149E+02	2,871E-08	5,068-109	1,122-132	3,128E-46	5,746E+04	5,746E+04	3,161E+00	2,264E-04
	6,451E-07	-1,802E-05	6,408E-17	1,051E+02	1,444E+03	2,902E+03				
820,00	1,137E+04	2,238E+02	1,712E+06	1,439E-01	1,060E+06	1,711E-04	5,199E+04	5,199E+04	2,240E+00	6,942E-03
	4,406E+01	2,990E+02	1,480E-08	2,497-112	1,326-136	1,131E-47	5,200E+04	5,200E+04	2,241E+00	1,638E-04
	5,550E-07	-1,622E-05	5,308E-17	1,073E+02	1,444E+03	2,923E+03				
840,00	7,950E+03	1,487E+02	1,396E+06	8,637E-02	1,007E+06	9,748E-05	4,704E+04	4,704E+04	1,592E+00	4,812E-03
	3,079E+01	2,154E+02	7,629E-09	1,231-115	1,567-140	4,088E-49	4,705E+04	4,705E+04	1,593E+00	1,201E-04
	4,806E-07	-1,457E-05	4,415E-17	1,098E+02	1,444E+03	2,944E+03				
860,00	5,568E+03	9,898E+01	1,139E+06	5,197E-02	9,572E+05	5,570E-05	4,257E+04	4,257E+04	1,133E+00	3,385E-03
	2,157E+01	1,553E+02	3,933E-09	6,066-119	1,851-144	1,478E-50	4,258E+04	4,258E+04	1,134E+00	8,938E-05
	4,190E-07	-1,305E-05	3,688E-17	1,125E+02	1,444E+03	2,965E+03				
880,00	3,907E+03	6,604E+01	9,301E+05	3,136E-02	9,100E+05	3,193E-05	3,852E+04	3,852E+04	8,087E-01	2,419E-03
	1,513E+01	1,119E+02	2,027E-09	2,990-122	2,188-148	5,343E-52	3,853E+04	3,853E+04	8,091E-01	6,767E-05
	3,676E-07	-1,165E-05	3,094E-17	1,155E+02	1,444E[illegible]3	2,985E+03				
900,00	2,747E+03	4,416E+01	7,606E+05	1,898E-02	8,653E+05	1,836E-05	3,485E+04	3,485E+04	5,781E-01	1,755E-03
	1,064E+01	8,063E+01	1,045E-09	1,473-125	2,585-152	1,932E-53	3,486E+04	3,486E+04	5,783E-01	5,225E-05
	3,247E-07	-1,037E-05	2,609E-17	1,189E+02	1,444E+03	3,005E+03				
920,00	1,935E+03	2,960E+01	6,227E+05	1,151E-02	8,231E+05	1,059E-05	3,153E+04	3,153E+04	4,140E-01	1,292E-03
	7,495E+00	5,811E+01	5,388E-10	7,261-129	3,054-156	6,983E-55	3,155E+04	3,154E+04	4,142E-01	4,125E-05
	2,886E-07	-9,202E-06	2,210E-17	1,226E+02	1,444E+03	3,025E+03				
940,00	1,366E+03	1,988E+01	5,103E+05	7,006E-03	7,831E+05	6,125E-06	2,853E+04	2,853E+04	2,971E-01	9,648E-04
	5,290E+00	4,188E+01	2,778E-10	3,578-132	3,609-160	2,525E-56	2,854E+04	2,854E+04	2,972E-01	3,341E-05
	2,581E-07	-8,134E-06	1,883E-17	1,267E+02	1,444E+03	3,045E+03				
960,00	9,658E+02	1,338E+01	4,[illegible]87E+05	4,274E-03	7,453E+05	3,553E-06	2,582E+04	2,582E+04	2,135E-01	7,298E-04
	3,741E+00	3,018E+01	1,432E-10	1,764-135	4,264-164	9,127E-58	2,583E+04	2,583E+04	2,137E-01	2,783E-05
	2,322E-07	-7,162E-06	1,612E-17	1,313E+02	1,444E+03	3,064E+03				
980,00	6,842E+02	9,027E+00	3,439E+05	2,615E-03	7,095E+05	2,068E-06	2,336E+04	2,336E+04	1,538E-01	5,586E-04
	2,650E+00	2,175E+01	7,381E-11	8,692-139	5,039-168	3,300E-59	2,337E+04	2,337E+04	1,539E-01	2,393E-05
	2,101E-07	-6,281E-06	1,388E-17	1,364E+02	1,444E+03	3,083E+03				
1000,00	4,857E+02	6,103E+00	2,827E+05	1,604E-03	6,755E+05	1,207E-06	2,114E+04	2,114E+04	1,109E-01	4,320E-04
	1,881E+00	1,567E+01	3,805E-11	4,284-142	5,9[illegible]4-172	1,193E-60	2,115E+04	2,115E+04	1,110E-01	2,128E-05
	1,911E-07	-5,486E-06	1,202E-17	1,420E+02	1,444E+03	3,102E+03				
1040,00	2,461E+02	2,807E+00	1,918E+05	6,082E-04	6,130E+05	4,147E-07	1,731E+04	1,731E+04	5,806E-02	2,651E-04
	9,531E-01	8,139E+00	1,011E-11	1,040-148	8,313-180	1,559E-63	1,731E+04	1,731E+04	5,809E-02	1,876E-05
	1,605E-07	-4,129E-06	9,180E-18	1,550E+02	1,444E+03	3,140E+03				
1080,00	1,256E+02	1,302E+00	1,306E+05	2,330E-04	5,568E+05	1,441E-07	1,417E+04	1,417E+04	3,059E-02	1,670E-04
	4,864E-01	4,227E+00	2,687E-12	2,527-155	1,161-187	2,038E-66	1,417E+04	1,417E+04	3,062E-02	1,901E-05
	1,371E-07	-3,054E-06	7,176E-18	1,705E+02	1,444E+03	3,176E+03				
1120,00	6,455E+01	6,087E-01	8,930E+04	9,022E-05	5,063E+05	5,067E-08	1,160E+04	1,160E+04	1,623E-02	1,072E-04
	2,500E-01	2,195E+00	7,142E-13	6,138-162	1,621-195	2,664E-69	1,160E+04	1,160E+04	1,625E-02	2,162E-05
	1,188E-07	-2,220E-06	5,741E-18	1,887E+02	1,444E+03	3,212E+03				
1160,00	3,342E+01	2,869E-01	6,131E+04	3,528E-05	4,609E+05	1,801E-08	9,498E+03	9,498E+03	8,673E-03	6,961E-05
	1,294E-01	1,140E+00	1,898E-13	1,491-168	2,263-203	3,482E-72	9,500E+03	9,500E+03	8,684E-03	2,666E-05
	1,041E-07	-1,588E-06	4,694E-18	2,093E+02	1,444E+03	3,247E+03				
1200,00	1,742E+01	1,363E-01	4,226E+04	1,394E-05	4,199E+05	6,473E-09	7,776E+03	7,776E+03	4,665E-03	4,559E-05
	6,748E-02	5,921E-01	5,044E-14	3,621-175	3,159-211	4,550E-75	7,778E+03	7,778E+03	4,673E-03	3,450E-05
	9,214E-08	-1,120E-06	3,914E-18	2,322E+02	1,444E+03	3,281E+03				

END OF TEST PROBLEM

TEST VALUES READ IN

NALTS = 130

I	ALTS(I),KM										
1	0,00	2	5,00	3	10,00	4	15,00	5	20,00	6	25,00
7	30,00	8	35,00	9	40,00	10	45,00	11	50,00	12	55,00
13	56,00	14	57,00	15	58,00	16	59,00	17	60,00	18	61,00
19	62,00	20	63,00	21	64,00	22	65,00	23	66,00	24	67,00
25	68,00	26	69,00	27	70,00	28	71,00	29	72,00	30	73,00
31	74,00	32	75,00	33	76,00	34	77,00	35	78,00	36	79,00
37	80,00	38	81,00	39	82,00	40	83,00	41	84,00	42	85,00
43	86,00	44	87,00	45	88,00	46	89,00	47	90,00	48	95,00
49	100,00	50	101,00	51	102,00	52	103,00	53	104,00	54	105,00
55	106,00	56	107,00	57	108,00	58	109,00	59	110,00	60	111,00
61	112,00	62	113,00	63	114,00	64	115,00	65	116,00	66	117,00
67	118,00	68	119,00	69	119,99	70	120,00	71	121,00	72	122,00
73	123,00	74	124,00	75	125,00	76	130,00	77	135,00	78	140,00
79	145,00	80	150,00	81	160,00	82	170,00	83	180,00	84	190,00
85	200,00	86	220,00	87	240,00	88	260,00	89	280,00	90	300,00
91	320,00	92	340,00	93	360,00	94	380,00	95	400,00	96	420,00
97	440,00	98	460,00	99	480,00	100	500,00	101	520,00	102	540,00
103	560,00	104	580,00	105	600,00	106	620,00	107	640,00	108	660,00
109	680,00	110	700,00	111	720,00	112	740,00	113	760,00	114	780,00
115	800,00	116	820,00	117	840,00	118	860,00	119	880,00	120	900,00
121	920,00	122	940,00	123	960,00	124	980,00	125	1000,00	126	1040,00
127	1080,00	128	1120,00	129	1160,00	130	1200,00				

```
IYRS =   77   IMONS =    9   IDAYS =    2
  ZT =  0,         HRS     GCO =  5,5000E+01 DEG     GLO =  2,3500E+02 DEG
```

INITIALIZATION CALL

```
TIF =  1,043924E+03 TAU =  2,384721E-02
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```
IYRS =   77   IMONS =    9   IDAYS =    2
  ZT =  0,         HRS     GCO =  9,5993E-01 RAD     GLO =  4,1015E+00 RAD

IDORN =   -1       UT =  8,0000E+00     GAT =  7,9966E+00     PLAT =  6,1087E-01     PLON =  4,1015E+00

HL =    23,663       SBAR =   157,717
```

ALT	N2 1/CC	O2 1/CC	O 1/CC	AR 1/CC	HE 1/CC	CO2 1/CC	E 1/CC	O+ 1/CC	M+ 1/CC	QDEF 1/(CC SEC)
	N 1/CC	NO 1/CC	NO2 1/CC	O2(SDG) 1/CC	O3 1/CC	H2O 1/CC	E 1/CC	O+ 1/CC	M+ 1/CC	N+ 1/CC
	PRESSURE DYNES/CM**2	FEHSEQ	DENSITY GRAMS/CC	DEN SC HT KM	TEMP DEG K	E TEMP DEG K				
0,00	1,982E+19	5,362E+18	1,100E+00	2,287E+17	1,175E+15	8,132E+15	0,	0,	0,	1,815E+02
	1,026E+00	1,000E+00	3,599E+10	3,400E+00	8,000E+11	1,866E+17	0,	0,	0,	0,
	1,013E+06	-0,	1,222E-03	9,075E+00	2,888E+02	2,888E+02				
5,00	1,204E+19	3,258E+18	1,100E+00	1,390E+17	7,141E+14	4,941E+15	0,	0,	0,	9,307E+01
	1,026E+00	1,000E+00	1,075E+10	3,400E+00	5,700E+11	2,411E+16	0,	0,	0,	0,
	5,426E+05	-3,804E-05	7,425E-04	9,617E+00	2,545E+02	2,545E+02				
10,00	6,638E+18	1,796E+18	1,100E+00	7,659E+16	3,936E+14	2,723E+15	0,	0,	0,	4,773E+01
	1,026E+00	1,000E+00	2,781E+09	3,400E+00	1,100E+12	3,976E+14	0,	0,	0,	0,
	2,654E+05	-1,205E-04	4,092E-04	7,453E+00	2,259E+02	2,259E+02				
15,00	3,209E+18	8,680E+17	1,100E+00	3,702E+16	1,903E+14	1,316E+15	0,	0,	0,	2,447E+01
	1,026E+00	1,000E+00	1,924E+09	3,400E+00	2,500E+12	2,065E+13	0,	0,	0,	0,
	1,222E+05	-2,416E-04	1,978E-04	6,488E+00	2,151E+02	2,151E+02				
20,00	1,453E+18	3,931E+17	1,100E+00	1,677E+16	8,616E+13	5,961E+14	0,	0,	0,	1,255E+01
	1,026E+00	1,000E+00	2,658E+09	3,400E+00	4,800E+12	4,511E+12	0,	0,	0,	0,
	5,538E+04	-4,104E-04	8,958E-05	6,212E+00	2,153E+02	2,153E+02				
25,00	6,500E+17	1,758E+17	1,100E+00	7,500E+15	3,854E+13	2,667E+14	0,	0,	0,	6,435E+00
	1,026E+00	1,000E+00	3,995E+09	3,400E+00	4,300E+12	2,250E+12	0,	0,	0,	0,
	2,544E+04	-6,353E-04	4,007E-05	6,253E+00	2,211E+02	2,211E+02				
30,00	2,952E+17	7,986E+16	1,100E+00	3,406E+15	1,750E+13	1,211E+14	0,	0,	0,	3,300E+00
	1,026E+00	1,000E+00	4,267E+09	3,400E+00	2,500E+12	1,406E+12	0,	0,	0,	0,
	1,200E+04	-9,232E-04	1,820E-05	6,434E+00	2,297E+02	2,297E+02				
35,00	1,377E+17	3,724E+16	1,100E+00	1,588E+15	8,163E+12	5,648E+13	0,	0,	0,	1,692E+00
	1,026E+00	1,000E+00	3,022E+09	3,400E+00	1,400E+12	8,036E+11	0,	0,	0,	0,
	5,843E+03	-1,281E-03	8,487E-06	6,686E+00	2,398E+02	2,398E+02				
40,00	6,626E+16	1,793E+16	1,100E+00	7,646E+14	3,929E+12	2,719E+13	0,	0,	0,	8,677E-01
	1,026E+00	1,000E+00	1,746E+09	3,400E+00	6,100E+11	3,957E+11	0,	0,	0,	0,
	2,937E+03	-1,711E-03	4,085E-06	7,005E+00	2,504E+02	2,504E+02				
45,00	3,307E+16	8,946E+15	1,100E+00	3,816E+14	1,961E+12	1,357E+13	0,	0,	0,	4,450E-01
	1,026E+00	1,000E+00	9,685E+08	3,400E+00	1,823E+11	1,797E+11	0,	0,	0,	0,
	1,520E+03	-2,205E-03	2,039E-06	7,399E+00	2,596E+02	2,596E+02				
50,00	1,715E+16	4,640E+15	1,100E+00	1,979E+14	1,017E+12	7,037E+12	0,	0,	0,	2,282E-01
	1,026E+00	1,000E+00	5,139E+08	3,400E+00	5,450E+10	8,158E+10	0,	0,	0,	0,
	8,015E+02	-2,724E-03	1,057E-06	7,837E+00	2,640E+02	2,640E+02				
55,00	9,198E+15	2,488E+15	1,100E+00	1,061E+14	5,454E+11	3,773E+12	0,	0,	0,	1,170E-01
	1,026E+00	1,000E+04	2,574E+08	3,400E+00	1,629E+10	3,848E+10	0,	0,	0,	0,
	4,239E+02	-3,204E-03	5,671E-07	8,178E+00	2,604E+02	2,604E+02				
56,00	8,141E+15	2,202E+15	1,100E+00	9,394E+13	4,827E+11	3,340E+12	0,	0,	0,	1,024E-01
	1,026E+00	4,517E+04	2,206E+08	3,400E+00	1,364E+10	3,326E+10	0,	0,	0,	0,
	3,726E+02	-3,290E-03	5,019E-07	8,215E+00	2,585E+02	2,585E+02				
57,00	7,210E+15	1,950E+15	1,100E+00	8,319E+13	4,275E+11	2,958E+12	0,	0,	0,	8,958E-02
	1,026E+00	1,284E+05	1,891E+08	3,400E+00	1,261E+10	2,877E+10	0,	0,	0,	0,
	3,272E+02	-3,371E-03	4,445E-07	8,236E+00	2,564E+02	2,564E+02				
58,00	6,386E+15	1,727E+15	1,100E+00	7,368E+13	3,786E+11	2,620E+12	0,	0,	0,	7,837E-02
	1,026E+00	2,844E+05	1,620E+08	3,400E+00	1,241E+10	2,490E+10	0,	0,	0,	0,
	2,870E+02	-3,448E-03	3,937E-07	8,241E+00	2,539E+02	2,539E+02				
59,00	5,655E+15	1,530E+15	1,100E+00	6,526E+13	3,353E+11	2,320E+12	0,	0,	0,	6,857E-02
	1,026E+00	5,529E+05	1,388E+08	3,400E+00	1,263E+10	2,156E+10	0,	0,	0,	0,
	2,514E+02	-3,520E-03	3,487E-07	8,228E+00	2,512E+02	2,512E+02				

60.00	5.007E+15	1.354E+15	1.100E+00	5.777E+13	2.969E+11	2.054E+12	0.	0.	0.	6.000E-02
	1.026E+00	1.000E+06	1.190E+08	3.400E+00	1.300E+10	1.867E+10	0.	0.	0.	0.
	2.200E+02	-3.588E-03	3.087E-07	8.196E+00	2.482E+02	2.482E+02				
61.00	4.430E+15	1.198E+15	4.149E+00	5.112E+13	2.627E+11	1.818E+12	0.	0.	0.	5.681E-02
	1.026E+00	1.717E+06	1.020E+08	3.400E+00	1.334E+10	1.617E+10	0.	0.	0.	0.
	1.921E+02	-3.651E-03	2.732E-07	8.147E+00	2.450E+02	2.450E+02				
62.00	3.917E+15	1.060E+15	1.565E+01	4.519E+13	2.322E+11	1.607E+12	0.	0.	0.	5.379E-02
	1.026E+00	2.799E+06	8.739E+07	3.400E+00	1.348E+10	1.399E+10	0.	0.	0.	0.
	1.675E+02	-3.711E-03	2.415E-07	8.080E+00	2.416E+02	2.416E+02				
63.00	3.459E+15	9.356E+14	5.904E+01	3.991E+13	2.051E+11	1.419E+12	0.	0.	0.	5.094E-02
	1.026E+00	4.302E+06	7.489E+07	3.400E+00	1.334E+10	1.209E+10	0.	0.	0.	0.
	1.457E+02	-3.766E-03	2.132E-07	7.996E+00	2.380E+02	2.380E+02				
64.00	3.050E+15	8.250E+14	2.227E+02	3.519E+13	1.808E+11	1.251E+12	0.	0.	0.	4.823E-02
	1.026E+00	6.187E+06	6.418E+07	3.400E+00	1.284E+10	1.044E+10	0.	0.	0.	0.
	1.265E+02	-3.818E-03	1.880E-07	7.897E+00	2.344E+02	2.344E+02				
65.00	2.685E+15	7.262E+14	8.401E+02	3.098E+13	1.592E+11	1.101E+12	0.	0.	0.	4.567E-02
	1.026E+00	8.300E+06	5.500E+07	3.400E+00	1.200E+10	8.999E+09	0.	0.	0.	0.
	1.096E+02	-3.868E-03	1.655E-07	7.785E+00	2.307E+02	2.307E+02				
66.00	2.359E+15	6.380E+14	3.169E+03	2.721E+13	1.399E+11	9.676E+11	0.	0.	0.	4.324E-02
	1.026E+00	1.042E+07	3.447E+07	3.400E+00	1.084E+10	7.743E+09	0.	0.	0.	0.
	9.475E+01	-3.915E-03	1.454E-07	7.662E+00	2.270E+02	2.270E+02				
67.00	2.068E+15	5.593E+14	1.195E+04	2.386E+13	1.226E+11	8.483E+11	0.	0.	0.	4.094E-02
	1.026E+00	1.233E+07	2.160E+07	3.400E+00	9.418E+09	6.649E+09	0.	0.	0.	0.
	8.172E+01	-3.960E-03	1.275E-07	7.530E+00	2.233E+02	2.233E+02				
68.00	1.808E+15	4.892E+14	4.509E+04	2.087E+13	1.072E+11	7.419E+11	0.	0.	0.	3.877E-02
	1.026E+00	1.395E+07	1.354E+07	3.400E+00	7.822E+09	5.696E+09	0.	0.	0.	0.
	7.030E+01	-4.004E-03	1.115E-07	7.393E+00	2.196E+02	2.196E+02				
69.00	1.578E+15	4.267E+14	1.701E+05	1.820E+13	9.354E+10	6.472E+11	0.	0.	0.	3.671E-02
	1.026E+00	1.530E+07	8.485E+06	3.400E+00	6.145E+09	4.867E+09	0.	0.	0.	0.
	6.034E+01	-4.048E-03	9.726E-08	7.251E+00	2.161E+02	2.161E+02				
70.00	1.372E+15	3.712E+14	6.416E+05	1.584E+13	8.138E+10	5.630E+11	0.	0.	0.	3.476E-02
	1.026E+00	1.650E+07	5.317E+06	3.400E+00	4.500E+09	4.146E+09	0.	0.	0.	0.
	5.166E+01	-4.091E-03	8.461E-08	7.108E+00	2.127E+02	2.127E+02				
71.00	1.191E+15	3.220E+14	2.420E+06	1.374E+13	7.059E+10	4.884E+11	0.	0.	0.	3.291E-02
	1.026E+00	1.772E+07	3.332E+06	9.513E+00	3.161E+09	3.521E+09	0.	0.	0.	0.
	4.412E+01	-4.135E-03	7.340E-08	6.965E+00	2.094E+02	2.094E+02				
72.00	1.030E+15	2.786E+14	9.129E+06	1.188E+13	6.106E+10	4.225E+11	0.	0.	0.	3.116E-02
	1.026E+00	1.912E+07	2.088E+06	2.662E+01	2.221E+09	2.980E+09	0.	0.	0.	0.
	3.760E+01	-4.181E-03	6.349E-08	6.824E+00	2.063E+02	2.063E+02				
73.00	8.881E+14	2.402E+14	3.444E+07	1.025E+13	5.266E+10	3.644E+11	0.	0.	0.	2.951E-02
	1.026E+00	2.079E+07	1.309E+06	7.448E+01	1.560E+09	2.512E+09	0.	0.	0.	0.
	3.196E+01	-4.228E-03	5.475E-08	6.687E+00	2.033E+02	2.033E+02				
74.00	7.636E+14	2.065E+14	1.299E+08	8.811E+12	4.528E+10	3.133E+11	0.	0.	0.	2.794E-02
	1.026E+00	2.277E+07	8.203E+05	2.084E+02	1.096E+09	2.110E+09	0.	0.	0.	0.
	2.711E+01	-4.278E-03	4.708E-08	6.556E+00	2.006E+02	2.006E+02				
75.00	6.546E+14	1.771E+14	4.900E+08	7.553E+12	3.881E+10	2.686E+11	0.	0.	0.	2.645E-02
	1.026E+00	2.500E+07	5.141E+05	5.831E+02	7.700E+08	1.764E+09	0.	0.	0.	0.
	2.295E+01	-4.330E-03	4.036E-08	6.430E+00	1.981E+02	1.981E+02				
76.00	5.595E+14	1.513E+14	1.675E+09	6.456E+12	3.317E+10	2.295E+11	0.	0.	0.	2.505E-02
	1.026E+00	2.732E+07	3.222E+05	1.632E+03	4.326E+08	1.467E+09	0.	0.	0.	0.
	1.939E+01	-4.386E-03	3.449E-08	6.311E+00	1.957E+02	1.957E+02				
77.00	4.768E+14	1.290E+14	4.647E+09	5.502E+12	2.827E+10	1.956E+11	0.	0.	0.	2.372E-02
	1.026E+00	2.948E+07	2.019E+05	4.565E+03	2.008E+08	1.214E+09	0.	0.	0.	0.
	1.635E+01	-4.447E-03	2.940E-08	6.200E+00	1.937E+02	1.937E+02				
78.00	4.052E+14	1.096E+14	1.043E+10	4.676E+12	2.403E+10	1.662E+11	0.	0.	0.	2.246E-02
	1.026E+00	3.122E+07	1.265E+05	1.277E+04	1.022E+08	9.991E+08	0.	0.	0.	0.
	1.376E+01	-4.511E-03	2.498E-08	6.096E+00	1.918E+02	1.918E+02				

79.00	3.435E+14	9.289E+13	1.923E+10	3.963E+12	2.037E+10	1.409E+11	0.	0.	0.	2.126E-02
	1.026E+00	3.238E+07	7.930E+04	3.574E+04	6.725E+07	8.169E+08	0.	0.	0.	0.
	1.157E+01	-4.581E-03	2.118E-08	6.002E+00	1.902E+02	1.902E+02				
80.00	2.904E+14	7.853E+13	3.000E+10	3.351E+12	1.722E+10	1.191E+11	0.	0.	0.	2.013E-02
	1.026E+00	3.300E+07	4.970E+04	1.000E+05	6.100E+07	6.633E+08	0.	0.	0.	0.
	9.710E+00	-4.656E-03	1.790E-08	5.916E+00	1.889E+02	1.889E+02				
81.00	2.450E+14	6.623E+13	4.114E+10	2.826E+12	1.452E+10	1.005E+11	0.	0.	0.	1.906E-02
	1.026E+00	3.332E+07	3.115E+04	1.100E+06	7.528E+07	5.345E+08	0.	0.	0.	0.
	8.143E+00	-4.737E-03	1.510E-08	5.838E+00	1.878E+02	1.878E+02				
82.00	2.062E+14	5.573E+13	5.174E+10	2.379E+12	1.223E+10	8.459E+10	0.	0.	0.	1.805E-02
	1.026E+00	3.377E+07	1.952E+04	6.231E+06	1.177E+08	4.273E+08	0.	0.	0.	0.
	6.822E+00	-4.824E-03	1.271E-08	5.770E+00	1.869E+02	1.869E+02				
83.00	1.732E+14	4.681E+13	6.220E+10	1.999E+12	1.027E+10	7.106E+10	0.	0.	0.	1.709E-02
	1.026E+00	3.480E+07	1.710E+04	2.118E+07	2.088E+08	3.385E+08	0.	0.	0.	0.
	5.713E+00	-4.918E-03	1.068E-08	5.710E+00	1.863E+02	1.863E+02				
84.00	1.453E+14	3.925E+13	7.415E+10	1.676E+12	8.614E+09	5.960E+10	0.	0.	0.	1.618E-02
	1.026E+00	3.664E+07	1.496E+04	4.907E+07	3.703E+08	2.656E+08	0.	0.	0.	0.
	4.782E+00	-5.019E-03	8.956E-09	5.659E+00	1.859E+02	1.859E+02				
85.00	1.217E+14	3.285E+13	9.000E+10	1.404E+12	7.213E+09	4.991E+10	0.	0.	0.	1.532E-02
	1.026E+00	3.889E+07	1.308E+04	8.600E+07	5.800E+08	2.063E+08	0.	0.	0.	0.
	4.002E+00	-5.127E-03	7.500E-09	5.616E+00	1.858E+02	1.858E+02				
86.00	1.018E+14	2.746E+13	1.126E+11	1.174E+12	6.033E+09	4.174E+10	0.	0.	0.	1.451E-02
	1.733E+00	4.095E+07	1.142E+04	1.237E+08	7.248E+08	1.585E+08	0.	0.	0.	0.
	3.349E+00	-5.243E-03	6.273E-09	5.582E+00	1.859E+02	1.859E+02				
87.00	8.503E+13	2.293E+13	1.440E+11	9.811E+11	5.042E+09	3.488E+10	0.	0.	0.	1.374E-02
	2.888E+00	4.318E+07	9.972E+03	1.553E+08	6.819E+08	1.203E+08	0.	0.	0.	0.
	2.804E+00	-5.367E-03	5.242E-09	5.556E+00	1.862E+02	1.862E+02				
88.00	7.100E+13	1.912E+13	1.825E+11	8.192E+11	4.210E+09	2.913E+10	0.	0.	0.	1.301E-02
	4.748E+00	4.553E+07	8.699E+03	1.783E+08	4.858E+08	9.023E+07	0.	0.	0.	0.
	2.349E+00	-5.500E-03	4.377E-09	5.538E+00	1.867E+02	1.867E+02				
89.00	5.926E+13	1.593E+13	2.158E+11	6.837E+11	3.514E+09	2.431E+10	0.	0.	0.	1.232E-02
	7.703E+00	4.796E+07	7.587E+03	1.927E+08	2.866E+08	6.681E+07	0.	0.	0.	0.
	1.969E+00	-5.641E-03	3.653E-09	5.528E+00	1.875E+02	1.875E+02				
90.00	4.945E+13	1.327E+13	2.166E+11	5.706E+11	2.932E+09	2.029E+10	1.353E+02	4.245E-08	1.353E+02	1.166E-02
	1.233E+01	5.040E+07	6.616E+03	2.000E+08	1.700E+08	4.881E+07	1.353E+02	4.245E-08	1.353E+02	1.521E-19
	1.652E+00	-5.792E-03	3.049E-09	5.525E+00	1.884E+02	1.884E+02				
95.00	2.010E+13	5.262E+12	3.521E+11	2.320E+11	1.192E+09	8.248E+09	3.679E+02	3.155E-06	3.679E+02	8.295E-02
	1.066E+02	6.051E+07	3.368E+03	1.400E+08	2.031E+07	8.310E+06	3.679E+02	3.155E-06	3.679E+02	5.081E-17
	7.015E-01	-6.689E-03	1.239E-09	5.613E+00	1.958E+02	1.958E+02				
100.00	8.381E+12	2.056E+12	4.225E+11	9.670E+10	4.969E+08	3.438E+09	1.000E+03	1.691E-04	1.000E+03	5.810E-01
	6.757E+02	6.204E+07	1.793E+03	2.886E+07	2.427E+06	1.075E+06	1.000E+03	1.691E-04	1.000E+03	1.175E-14
	3.124E-01	-7.863E-03	5.167E-10	5.834E+00	2.066E+02	2.066E+02				
101.00	7.066E+12	1.702E+12	4.191E+11	8.153E+10	4.190E+08	2.875E+09	1.000E+03	2.393E-04	1.000E+03	5.740E-01
	9.436E+02	6.107E+07	1.594E+03	1.972E+07	1.587E+06	7.031E+05	1.000E+03	2.393E-04	1.000E+03	2.226E-14
	2.676E-01	-8.139E-03	4.356E-10	5.869E+00	2.092E+02	2.092E+02				
102.00	5.967E+12	1.409E+12	4.097E+11	6.885E+10	3.538E+08	2.377E+09	1.001E+03	3.330E-04	1.001E+03	5.671E-01
	1.303E+03	5.963E+07	1.421E+03	1.348E+07	1.038E+06	4.605E+05	1.001E+03	3.330E-04	1.001E+03	4.155E-14
	2.299E-01	-8.431E-03	3.679E-10	5.945E+00	2.120E+02	2.120E+02				
103.00	5.047E+12	1.168E+12	3.947E+11	5.824E+10	2.993E+08	1.950E+09	1.002E+03	4.559E-04	1.002E+03	5.602E-01
	1.778E+03	5.780E+07	1.272E+03	9.209E+06	6.784E+05	3.028E+05	1.002E+03	4.559E-04	1.002E+03	7.645E-14
	1.980E-01	-8.742E-03	3.112E-10	6.002E+00	2.151E+02	2.151E+02				
104.00	4.276E+12	9.693E+11	3.750E+11	4.934E+10	2.536E+08	1.593E+09	1.004E+03	6.140E-04	1.004E+03	5.532E-01
	2.401E+03	5.565E+07	1.142E+03	6.293E+06	4.435E+05	2.007E+05	1.004E+03	6.140E-04	1.004E+03	1.387E-13
	1.710E-01	-9.075E-03	2.636E-10	6.061E+00	2.185E+02	2.185E+02				
105.00	3.629E+12	8.058E+11	3.517E+11	4.187E+10	2.152E+08	1.300E+09	1.005E+03	8.140E-04	1.005E+03	5.459E-01
	3.208E+03	5.327E+07	1.029E+03	4.300E+06	2.900E+05	1.346E+05	1.005E+03	8.140E-04	1.005E+03	2.484E-13
	1.481E-01	-9.431E-03	2.237E-10	6.119E+00	2.223E+02	2.223E+02				

106.00	3,084E+12	6,713E+11	3,259E+11	3,558E+10	1,829E+08	1,062E+09	1,008E+03	1,063E-03	1,008E+03	5,382E-01
	4,240E+03	5,072E+07	9,301E+02	2,938E+06	1,896E+05	9,165E+04	1,008E+03	1,063E-03	1,008E+03	4,390E-13
	1,287E-01	-9,816E-03	1,901E-10	6,177E+00	2,265E+02	2,265E+02				
107.00	2,625E+12	5,607E+11	2,988E+11	3,029E+10	1,556E+08	8,685E+08	1,011E+03	1,368E-03	1,011E+03	5,300E-01
	5,547E+03	4,808E+07	8,435E+02	2,008E+06	1,240E+05	6,359E+04	1,011E+03	1,368E-03	1,011E+03	7,660E-13
	1,123E-01	-1,023E-02	1,618E-10	6,234E+00	2,313E+02	2,313E+02				
108.00	2,238E+12	4,696E+11	2,714E+11	2,582E+10	1,327E+08	7,120E+08	1,014E+03	1,738E-03	1,014E+03	5,211E-01
	7,184E+03	4,540E+07	7,675E+02	1,372E+06	8,106E+04	4,512E+04	1,014E+03	1,738E-03	1,014E+03	1,320E-12
	9,822E-02	-1,069E-02	1,379E-10	6,290E+00	2,368E+02	2,368E+02				
109.00	1,910E+12	3,945E+11	2,444E+11	2,204E+10	1,133E+08	5,845E+08	1,018E+03	2,180E-03	1,018E+03	5,116E-01
	9,210E+03	4,272E+07	7,004E+02	9,376E+05	5,300E+04	3,283E+04	1,018E+03	2,180E-03	1,018E+03	2,246E-12
	8,626E-02	-1,119E-02	1,178E-10	6,347E+00	2,430E+02	2,430E+02				
110.00	1,633E+12	3,323E+11	2,187E+11	1,884E+10	9,681E+07	4,800E+08	1,022E+03	2,705E-03	1,022E+03	5,013E-01
	1,169E+04	4,009E+07	6,410E+02	6,407E+05	3,465E+04	2,457E+04	1,022E+03	2,705E-03	1,022E+03	3,775E-12
	7,605E-02	-1,174E-02	1,007E-10	6,404E+00	2,501E+02	2,501E+02				
111.00	1,398E+12	2,808E+11	1,946E+11	1,613E+10	8,287E+07	3,937E+08	1,027E+03	3,322E-03	1,027E+03	4,901E-01
	1,471E+04	3,753E+07	5,881E+02	4,378E+05	2,266E+04	1,893E+04	1,027E+03	3,322E-03	1,027E+03	6,262E-12
	6,732E-02	-1,234E-02	8,617E-11	6,467E+00	2,581E+02	2,581E+02				
112.00	1,198E+12	2,380E+11	1,724E+11	1,383E+10	7,105E+07	3,219E+08	1,032E+03	4,042E-03	1,032E+03	4,782E-01
	1,833E+04	3,505E+07	5,409E+02	2,992E+05	1,481E+04	1,502E+04	1,032E+03	4,042E-03	1,032E+03	1,026E-11
	5,986E-02	-1,302E-02	7,388E-11	6,540E+00	2,672E+02	2,672E+02				
113.00	1,029E+12	2,023E+11	1,522E+11	1,187E+10	6,102E+07	2,619E+08	1,038E+03	4,874E-03	1,038E+03	4,656E-01
	2,263E+04	3,266E+07	4,985E+02	2,044E+05	9,685E+03	1,225E+04	1,038E+03	4,874E-03	1,038E+03	1,657E-11
	5,345E-02	-1,376E-02	6,345E-11	6,622E+00	2,774E+02	2,774E+02				
114.00	8,858E+11	1,725E+11	1,341E+11	1,022E+10	5,252E+07	2,117E+08	1,044E+03	5,777E-03	1,044E+03	4,526E-01
	2,770E+04	3,039E+07	4,603E+02	1,397E+05	6,332E+03	1,025E+04	1,044E+03	5,777E-03	1,044E+03	2,642E-11
	4,796E-02	-1,458E-02	5,461E-11	6,714E+00	2,888E+02	2,888E+02				
115.00	7,644E+11	1,478E+11	1,180E+11	8,821E+09	4,533E+07	1,700E+08	1,050E+03	6,771E-03	1,050E+03	4,393E-01
	3,362E+04	2,823E+07	4,257E+02	9,546E+04	4,140E+03	8,734E+03	1,050E+03	6,771E-03	1,050E+03	4,152E-11
	4,323E-02	-1,548E-02	4,713E-11	6,815E+00	3,013E+02	3,013E+02				
116.00	6,623E+11	1,272E+11	1,038E+11	7,642E+09	3,927E+07	1,357E+08	1,057E+03	7,865E-03	1,057E+03	4,264E-01
	4,045E+04	2,621E+07	3,941E+02	6,523E+04	2,707E+03	7,517E+03	1,057E+03	7,865E-03	1,057E+03	6,429E-11
	3,914E-02	-1,644E-02	4,083E-11	6,926E+00	3,146E+02	3,146E+02				
117.00	5,769E+11	1,103E+11	9,144E+10	6,656E+09	3,420E+07	1,079E+08	1,065E+03	9,045E-03	1,065E+03	4,146E-01
	4,828E+04	2,435E+07	3,653E+02	4,457E+04	1,770E+03	6,452E+03	1,065E+03	9,045E-03	1,065E+03	9,797E-11
	3,560E-02	-1,745E-02	3,557E-11	7,046E+00	3,283E+02	3,283E+02				
118.00	5,064E+11	9,663E+10	8,071E+10	5,843E+09	3,003E+07	8,588E+07	1,073E+03	1,028E-02	1,073E+03	4,048E-01
	5,716E+04	2,272E+07	3,389E+02	3,046E+04	1,157E+03	5,429E+03	1,073E+03	1,028E-02	1,073E+03	1,467E-10
	3,250E-02	-1,844E-02	3,122E-11	7,176E+00	3,414E+02	3,414E+02				
119.00	4,494E+11	8,579E+10	7,156E+10	5,186E+09	2,665E+07	6,897E+07	1,082E+03	1,152E-02	1,082E+03	3,984E-01
	6,716E+04	2,135E+07	3,146E+02	2,081E+04	7,566E+02	4,382E+03	1,082E+03	1,152E-02	1,082E+03	2,155E-10
	2,978E-02	-1,934E-02	2,771E-11	7,315E+00	3,524E+02	3,524E+02				
119.99	4,053E+11	7,767E+10	6,397E+10	4,677E+09	2,404E+07	5,660E+07	1,091E+03	1,268E-02	1,091E+03	3,974E-01
	7,819E+04	2,035E+07	2,924E+02	1,428E+04	4,968E+02	3,310E+03	1,091E+03	1,268E-02	1,091E+03	3,085E-10
	2,737E-02	-2,001E-02	2,499E-11	7,462E+00	3,593E+02	3,593E+02				
120.00	4,050E+11	7,760E+10	6,390E+10	4,673E+09	2,401E+07	5,650E+07	1,091E+03	1,269E-02	1,091E+03	3,974E-01
	7,831E+04	2,034E+07	2,922E+02	1,422E+04	4,947E+02	3,299E+03	1,091E+03	1,269E-02	1,091E+03	3,096E-10
	2,735E-02	-9,177E-06	2,497E-11	7,464E+00	3,593E+02	3,593E+02				
121.00	3,554E+11	6,727E+10	5,820E+10	3,952E+09	2,310E+07	4,719E+07	1,101E+03	1,498E-02	1,101E+03	3,872E-01
	9,065E+04	1,907E+07	2,714E+02	9,719E+03	3,235E+02	2,794E+03	1,101E+03	1,498E-02	1,101E+03	4,468E-10
	2,514E-02	-9,821E-06	2,192E-11	7,872E+00	3,755E+02	3,755E+02				
122.00	3,139E+11	5,872E+10	5,328E+10	3,370E+09	2,227E+07	3,976E+07	1,111E+03	1,758E-02	1,111E+03	3,786E-01
	1,042E+05	1,794E+07	2,523E+02	6,641E+03	2,115E+02	2,367E+03	1,111E+03	1,758E-02	1,111E+03	6,343E-10
	2,319E-02	-1,046E-05	1,937E-11	8,279E+00	3,912E+02	3,912E+02				
123.00	2,789E+11	5,158E+10	4,898E+10	2,894E+09	2,152E+07	3,375E+07	1,122E+03	2,052E-02	1,122E+03	3,714E-01
	1,189E+05	1,694E+07	2,345E+02	4,538E+03	1,383E+02	2,005E+03	1,122E+03	2,052E-02	1,122E+03	8,870E-10
	2,147E-02	-1,111E-05	1,721E-11	8,683E+00	4,066E+02	4,066E+02				

124,00	2,491E+11	4,557E+10	4,521E+10	2,501E+09	2,082E+07	2,885E+07	1,133E+03	2,383E-02	1,133E+03	3,655E-01
	1,349E+05	1,606E+07	2,181E+02	3,101E+03	9,041E+01	1,698E+03	1,133E+03	2,383E-02	1,133E+03	1,223E-09
	1,993E-02	-1,175E-05	1,538E-11	9,084E+00	4,216E+02	4,216E+02				
125,00	2,236E+11	4,047E+10	4,188E+10	2,175E+09	2,019E+07	2,482E+07	1,145E+03	2,757E-02	1,145E+03	3,608E-01
	1,520E+05	1,529E+07	2,029E+02	2,119E+03	5,911E+01	1,438E+03	1,145E+03	2,757E-02	1,145E+03	1,665E-09
	1,856E-02	-1,239E-05	1,381E-11	9,484E+00	4,362E+02	4,362E+02				
130,00	1,379E+11	2,380E+10	2,987E+10	1,162E+09	1,763E+07	1,263E+07	1,215E+03	5,433E-02	1,215E+03	3,511E-01
	2,524E+05	1,211E+07	1,438E+02	3,158E+02	7,063E+00	6,273E+02	1,215E+03	5,433E-02	1,215E+03	6,570E-09
	1,343E-02	-1,551E-05	8,552E-12	1,144E+01	5,044E+02	5,044E+02				
135,00	9,157E+10	1,514E+10	2,252E+10	6,800E+08	1,579E+07	7,077E+06	1,302E+03	1,012E-01	1,302E+03	3,601E-01
	3,682E+05	9,668E+06	1,081E+02	4,705E+01	8,439E-01	2,735E+02	1,302E+03	1,011E-01	1,302E+03	2,073E-08
	1,013E-02	-1,848E-05	5,708E-12	1,333E+01	5,648E+02	5,648E+02				
140,00	6,401E+10	1,019E+10	1,765E+10	4,241E+08	1,439E+07	4,246E+06	1,409E+03	1,820E-01	1,409E+03	3,854E-01
	4,833E+05	7,801E+06	8,997E+01	7,010E+00	1,008E-01	1,193E+02	1,409E+03	1,820E-01	1,409E+03	5,541E-08
	7,880E-03	-2,126E-05	4,016E-12	1,514E+01	6,184E+02	6,184E+02				
145,00	4,647E+10	7,145E+09	1,424E+10	2,773E+08	1,329E+07	2,679E+06	1,540E+03	3,206E-01	1,540E+03	4,275E-01
	5,834E+05	6,369E+06	8,210E+01	1,044E+00	1,205E-02	5,201E+01	1,540E+03	3,206E-01	1,540E+03	1,309E-07
	6,266E-03	-2,384E-05	2,939E-12	1,688E+01	6,659E+02	6,659E+02				
150,00	3,474E+10	5,169E+09	1,175E+10	1,880E+08	1,240E+07	1,756E+06	1,699E+03	5,583E-01	1,699E+03	4,893E-01
	6,606E+05	5,260E+06	7,403E+01	1,556E-01	1,440E-03	2,268E+01	1,699E+03	5,582E-01	1,699E+03	2,823E-07
	5,070E-03	-2,620E-05	2,215E-12	1,854E+01	7,081E+02	7,081E+02				
160,00	2,069E+10	2,899E+09	8,391E+09	9,348E+07	1,102E+07	8,216E+05	2,124E+03	1,668E+00	2,123E+03	6,948E-01
	7,459E+05	3,707E+06	4,638E+01	3,455E-03	2,055E-05	4,312E+00	2,124E+03	1,668E+00	2,123E+03	1,103E-06
	3,449E-03	-3,029E-05	1,346E-12	2,161E+01	7,787E+02	7,787E+02				
170,00	1,309E+10	1,735E+09	6,272E+09	5,011E+07	1,001E+07	4,162E+05	2,743E+03	4,878E+00	2,739E+03	1,061E+00
	7,700E+05	2,710E+06	3,330E+01	7,669E-05	2,934E-07	8,198E-01	2,743E+03	4,877E+00	2,739E+03	3,821E-06
	2,437E-03	-3,357E-05	8,712E-13	2,438E+01	8,342E+02	8,342E+02				
180,00	8,631E+09	1,086E+09	4,837E+09	2,828E+07	9,210E+06	2,228E+05	3,647E+03	1,440E+01	3,633E+03	1,811E+00
	7,693E+05	2,042E+06	2,391E+01	1,703E-06	4,189E-09	1,559E-01	3,647E+03	1,439E+01	3,633E+03	1,269E-05
	1,769E-03	-3,611E-05	5,897E-13	2,686E+01	8,781E+02	8,781E+02				
190,00	5,862E+09	7,021E+08	3,814E+09	1,656E+07	8,562E+06	1,240E+05	4,971E+03	4,321E+01	4,927E+03	3,220E+00
	7,577E+05	1,574E+06	1,717E+01	3,780E-08	5,981E-11	2,964E-02	4,971E+03	4,320E+01	4,927E+03	4,144E-05
	1,311E-03	-3,799E-05	4,125E-13	2,910E+01	9,126E+02	9,126E+02				
200,00	4,069E+09	4,646E+08	3,057E+09	9,963E+06	8,018E+06	7,108E+04	6,913E+03	1,313E+02	6,782E+03	5,986E+00
	7,289E+05	1,236E+06	1,233E+01	8,391E-10	8,539E-13	5,636E-03	6,913E+03	1,313E+02	6,782E+03	1,320E-04
	9,875E-04	-3,928E-05	2,959E-13	3,111E+01	9,399E+02	9,399E+02				
220,00	2,051E+09	2,137E+08	2,032E+09	3,816E+06	7,138E+06	2,480E+04	1,394E+04	1,194E+03	1,274E+04	2,178E+01
	5,915E+05	7,936E+05	6,354E+00	4,135E-13	1,741E-16	2,037E-04	1,394E+04	1,193E+03	1,274E+04	1,119E-03
	5,820E-04	-4,040E-05	1,611E-13	3,462E+01	9,785E+02	9,785E+02				
240,00	1,076E+09	1,026E+08	1,391E+09	1,537E+06	6,437E+06	9,125E+03	2,870E+04	8,778E+03	1,992E+04	6,841E+01
	3,748E+05	5,282E+05	3,276E+00	2,038E-16	3,548E-20	7,366E-06	2,870E+04	8,775E+03	1,992E+04	5,831E-03
	3,569E-04	-3,995E-05	9,261E-14	3,764E+01	1,003E+03	1,003E+03				
260,00	5,787E+08	5,064E+07	9,700E+08	6,386E+05	5,851E+06	3,473E+03	5,786E+04	3,829E+04	1,957E+04	1,335E+02
	2,016E+05	3,598E+05	1,689E+00	1,004E-19	7,231E-24	2,663E-07	5,785E+04	3,828E+04	1,958E+04	1,506E-02
	2,257E-04	-3,834E-05	5,546E-14	4,036E+01	1,018E+03	1,018E+03				
280,00	3,164E+08	2,544E+07	6,843E+08	2,710E+05	5,345E+06	1,352E+03	1,097E+05	9,737E+04	1,230E+04	1,576E+02
	1,102E+05	2,488E+05	8,705E-01	4,950E-23	1,474E-27	9,627E-09	1,097E+05	9,735E+04	1,231E+04	2,287E-02
	1,464E-04	-3,590E-05	3,430E-14	4,290E+01	1,027E+03	1,027E+03				
300,00	1,750E+08	1,294E+07	4,867E+08	1,167E+05	4,898E+06	5,350E+02	1,883E+05	1,819E+05	6,445E+03	1,410E+02
	6,094E+04	1,739E+05	4,488E-01	2,439E-26	3,004E-31	3,481E-10	1,882E+05	1,818E+05	6,448E+03	2,572E-02
	9,696E-05	-3,292E-05	2,180E-14	4,531E+01	1,033E+03	1,033E+03				
320,00	9,758E+07	6,646E+06	3,481E+08	5,084E+04	4,498E+06	2,142E+02	2,838E+05	2,806E+05	3,256E+03	1,071E+02
	3,399E+04	1,224E+05	2,313E-01	1,202E-29	6,124E-35	1,258E-11	2,837E+05	2,804E+05	3,257E+03	2,412E-02
	6,543E-05	-2,964E-05	1,417E-14	4,763E+01	1,037E+03	1,037E+03				
340,00	5,477E+07	3,437E+06	2,501E+08	2,234E+04	4,138E+06	8,658E+01	3,667E+05	3,650E+05	1,655E+03	7,029E+01
	1,908E+04	8,664E+04	1,193E-01	5,925E-33	1,248E-38	4,549E-13	3,666E+05	3,649E+05	1,656E+03	1,925E-02
	4,484E-05	-2,627E-05	9,403E-15	4,984E+01	1,040E+03	1,040E+03				

360.00	3.091E+07	1.789E+06	1.802E+08	9.885E+03	3.810E+06	3.527E+01	4.000E+05	3.991E+05	8.545E+02	3.968E+01
	1.077E+04	6.155E+04	6.148E-02	2.920E-36	2.544E-42	1.645E-14	4.000E+05	3.991E+05	8.548E+02	1.301E-02
	3.116E-05	-2.297E-05	6.347E-15	5.194E+01	1.041E+03	1.041E+03				
380.00	1.752E+07	9.354E+05	1.303E+08	4.402E+03	3.512E+06	1.447E+01	3.619E+05	3.615E+05	4.483E+02	1.892E+01
	6.103E+03	4.384E+04	3.169E-02	1.439E-39	5.186E-46	5.946E-16	3.620E+05	3.615E+05	4.485E+02	7.299E-03
	2.191E-05	-1.985E-05	4.350E-15	5.390E+01	1.042E+03	1.042E+03				
400.00	9.976E+06	4.915E+05	9.442E+07	1.972E+03	3.239E+06	5.973E+00	3.275E+05	3.273E+05	2.389E+02	9.198E+00
	3.474E+03	3.130E+04	1.634E-02	7.092E-43	1.057E-49	2.150E-17	3.277E+05	3.274E+05	2.390E+02	4.134E-03
	1.557E-05	-1.699E-05	3.020E-15	5.572E+01	1.043E+03	1.043E+03				
420.00	5.700E+06	2.594E+05	6.858E+07	8.878E+02	2.990E+06	2.480E+00	2.963E+05	2.962E+05	1.291E+02	4.560E+00
	1.985E+03	2.238E+04	8.423E-03	3.495E-46	2.154E-53	7.772E-19	2.966E+05	2.965E+05	1.292E+02	2.367E-03
	1.117E-05	-1.443E-05	2.121E-15	5.740E+01	1.043E+03	1.043E+03				
440.00	3.269E+06	1.375E+05	4.991E+07	4.018E+02	2.761E+06	1.036E+00	2.681E+05	2.681E+05	7.068E+01	2.308E+00
	1.139E+03	1.603E+04	4.342E-03	1.723E-49	4.391E-57	2.810E-20	2.686E+05	2.685E+05	7.070E+01	1.374E-03
	8.079E-06	-1.217E-05	1.504E-15	5.894E+01	1.043E+03	1.043E+03				
460.00	1.881E+06	7.312E+04	3.640E+07	1.827E+02	2.551E+06	4.347E-01	2.426E+05	2.426E+05	3.911E+01	1.197E+00
	6.552E+02	1.149E+04	2.238E-03	8.490E-53	8.951E-61	1.016E-21	2.433E+05	2.432E+05	3.913E+01	8.093E-04
	5.894E-06	-1.021E-05	1.076E-15	6.037E+01	1.044E+03	1.044E+03				
480.00	1.086E+06	3.905E+04	2.660E+07	8.351E+01	2.359E+06	1.834E-01	2.195E+05	2.195E+05	2.186E+01	6.381E-01
	3.783E+02	8.243E+03	1.154E-03	4.184E-56	1.824E-64	3.672E-23	2.204E+05	2.204E+05	2.187E+01	4.859E-04
	4.335E-06	-8.525E-06	7.750E-16	6.170E+01	1.044E+03	1.044E+03				
500.00	6.293E+05	2.093E+04	1.948E+07	3.834E+01	2.182E+06	7.781E-02	1.986E+05	1.986E+05	1.233E+01	3.521E-01
	2.192E+02	5.918E+03	5.949E-04	2.062E-59	3.719E-68	1.328E-24	1.997E+05	1.997E+05	1.234E+01	2.984E-04
	3.215E-06	-7.092E-06	5.623E-16	6.296E+01	1.044E+03	1.044E+03				
520.00	3.657E+05	1.126E+04	1.428E+07	1.768E+01	2.019E+06	3.317E-02	1.797E+05	1.797E+05	7.015E+00	2.025E-01
	1.274E+02	4.251E+03	3.067E-04	1.016E-62	7.580E-72	4.800E-26	1.810E+05	1.810E+05	7.017E+00	1.886E-04
	2.404E-06	-5.880E-06	4.105E-16	6.420E+01	1.044E+03	1.044E+03				
540.00	2.132E+05	6.080E+03	1.050E+07	8.193E+00	1.869E+06	1.421E-02	1.626E+05	1.626E+05	4.021E+00	1.222E-01
	7.427E+01	3.055E+03	1.581E-04	5.008E-66	1.545E-75	1.735E-27	1.640E+05	1.640E+05	4.022E+00	1.234E-04
	1.814E-06	-4.861E-06	3.015E-16	6.543E+01	1.044E+03	1.044E+03				
560.00	1.247E+05	3.295E+03	7.727E+06	3.813E+00	1.731E+06	6.119E-03	1.472E+05	1.471E+05	2.321E+00	7.776E-02
	4.344E+01	2.196E+03	8.149E-05	2.468E-69	3.149E-79	6.273E-29	1.485E+05	1.485E+05	2.322E+00	8.429E-05
	1.382E-06	-4.006E-06	2.228E-16	6.670E+01	1.044E+03	1.044E+03				
580.00	7.317E+04	1.792E+03	5.698E+06	1.782E+00	1.604E+06	2.648E-03	1.331E+05	1.331E+05	1.349E+00	5.213E-02
	2.548E+01	1.580E+03	4.201E-05	1.216E-72	6.419E-83	2.268E-30	1.345E+05	1.345E+05	1.350E+00	6.047E-05
	1.063E-06	-3.292E-06	1.655E-16	6.805E+01	1.044E+03	1.044E+03				
600.00	4.306E+04	9.778E+02	4.209E+06	8.367E-01	1.487E+06	1.151E-03	1.205E+05	1.205E+05	7.899E-01	3.667E-02
	1.500E+01	1.136E+03	2.166E-05	5.995E-76	1.308E-86	8.199E-32	1.218E+05	1.218E+05	7.907E-01	4.581E-05
	8.273E-07	-2.696E-06	1.238E-16	6.953E+01	1.044E+03	1.044E+03				
620.00	2.542E+04	5.355E+02	3.115E+06	3.946E-01	1.379E+06	5.028E-04	1.090E+05	1.090E+05	4.655E-01	2.687E-02
	8.852E+00	8.176E+02	1.116E-05	2.955E-79	2.667E-90	2.964E-33	1.102E+05	1.102E+05	4.662E-01	3.677E-05
	6.515E-07	-2.200E-06	9.313E-17	7.117E+01	1.044E+03	1.044E+03				
640.00	1.505E+04	2.943E+02	2.309E+06	1.868E-01	1.280E+06	2.207E-04	9.864E+04	9.864E+04	2.762E-01	2.034E-02
	5.241E+00	5.884E+02	5.755E-06	1.456E-82	5.436E-94	1.072E-34	9.970E+04	9.970E+04	2.768E-01	3.137E-05
	5.194E-07	-1.788E-06	7.057E-17	7.304E+01	1.044E+03	1.044E+03				
660.00	8.935E+03	1.622E+02	1.715E+06	8.866E-02	1.188E+06	9.732E-05	8.925E+04	8.925E+04	1.650E-01	1.576E-02
	3.112E+00	4.236E+02	2.967E-06	7.176E-86	1.108E-97	3.874E-36	9.019E+04	9.019E+04	1.656E-01	2.856E-05
	4.196E-07	-1.446E-06	5.387E-17	7.520E+01	1.044E+03	1.044E+03				
680.00	5.322E+03	8.976E+01	1.275E+06	4.244E-02	1.103E+06	4.311E-05	8.076E+04	8.076E+04	9.929E-02	1.243E-02
	1.854E+00	3.049E+02	1.530E-06	3.537E-89	2.258-101	1.401E-37	8.158E+04	8.158E+04	9.981E-02	2.789E-05
	3.436E-07	-1.163E-06	4.147E-17	7.771E+01	1.044E+03	1.044E+03				
700.00	3.179E+03	4.983E+01	9.502E+05	2.035E-02	1.025E+06	1.919E-05	7.307E+04	7.307E+04	6.020E-02	9.918E-03
	1.107E+00	2.196E+02	7.885E-07	1.743E-92	4.603-105	5.064E-39	7.379E+04	7.379E+04	6.066E-02	2.935E-05
	2.851E-07	-9.300E-07	3.221E-17	8.066E+01	1.044E+03	1.044E+03				
720.00	1.904E+03	2.775E+01	7.092E+05	9.803E-03	9.525E+05	8.580E-06	6.612E+04	6.612E+04	3.678E-02	7.978E-03
	6.633E-01	1.581E+02	4.065E-07	8.590E-96	9.382-109	1.831E-40	6.674E+04	6.674E+04	3.719E-02	3.326E-05
	2.398E-07	-7.381E-07	2.526E-17	8.412E+01	1.044E+03	1.044E+03				

740.00	1,144E+03	1,551E+01	5,301E+05	4,740E-03	8,856E+05	3,853E-06	5,983E+04	5,983E+04	2,266E-02	6,453E-03
	3,965E-01	1,139E+02	2,095E-07	4,233E-99	1,912-112	6,619E-42	6,036E+04	6,036E+04	2,302E-02	4,033E-05
	2,042E-07	-5,812E-07	2,002E-17	8,818E+01	1,044E+03	1,044E+03				
760.00	6,894E+02	8,694E+00	3,969E+05	2,302E-03	8,238E+05	1,739E-06	5,413E+04	5,413E+04	1,408E-02	5,239E-03
	2,401E-01	8,201E+01	1,080E-07	2,086-102	3,898-116	2,393E-43	5,460E+04	5,460E+04	1,440E-02	5,166E-05
	1,760E-07	-4,538E-07	1,605E-17	9,294E+01	1,044E+03	1,044E+03				
780.00	4,166E+02	4,890E+00	2,977E+05	1,122E-03	7,665E+05	7,879E-07	4,898E+04	4,898E+04	8,829E-03	4,263E-03
	1,451E-01	5,907E+01	5,569E-08	1,028-105	7,945-120	8,651E-45	4,938E+04	4,938E+04	9,111E-03	6,891E-05
	1,534E-07	-3,510E-07	1,302E-17	9,848E+01	1,044E+03	1,044E+03				
800.00	2,524E+02	2,759E+00	2,236E+05	5,493E-04	7,136E+05	3,586E-07	4,432E+04	4,432E+04	5,589E-03	3,475E-03
	8,791E-02	4,255E+01	2,871E-08	5,068-109	1,619-123	3,128E-46	4,467E+04	4,467E+04	5,836E-03	9,449E-05
	1,351E-07	-2,689E-07	1,070E-17	1,049E+02	1,044E+03	1,044E+03				
820.00	1,534E+02	1,562E+00	1,682E+05	2,699E-04	6,646E+05	1,640E-07	4,010E+04	4,010E+04	3,573E-03	2,836E-03
	5,342E-02	3,066E+01	1,480E-08	2,497-112	3,301-127	1,131E-47	4,040E+04	4,040E+04	3,790E-03	1,318E-04
	1,201E-07	-2,039E-07	8,894E-18	1,122E+02	1,044E+03	1,044E+03				
840.00	9,345E+01	8,869E-01	1,268E+05	1,332E-04	6,191E+05	7,528E-08	3,629E+04	3,629E+04	2,307E-03	2,317E-03
	3,255E-02	2,209E+01	7,629E-09	1,231-115	6,728-131	4,088E-49	3,654E+04	3,654E+04	2,497E-03	1,858E-04
	1,075E-07	-1,532E-07	7,488E-18	1,205E+02	1,044E+03	1,044E+03				
860.00	5,710E+01	5,052E-01	9,568E+04	6,596E-05	5,771E+05	3,472E-08	3,283E+04	3,283E+04	1,505E-03	1,893E-03
	1,989E-02	1,591E+01	3,933E-09	6,066-119	1,371-134	1,478E-50	3,305E+04	3,305E+04	1,672E-03	2,632E-04
	9,697E-08	-1,140E-07	6,380E-18	1,297E+02	1,044E+03	1,044E+03				
880.00	3,498E+01	2,887E-01	7,233E+04	3,280E-05	5,380E+05	1,608E-08	2,971E+04	2,971E+04	9,921E-04	1,548E-03
	1,218E-02	1,146E+01	2,027E-09	2,990-122	2,795-138	5,343E-52	2,990E+04	2,990E+04	1,138E-03	3,737E-04
	8,798E-08	-8,404E-08	5,499E-18	1,398E+02	1,044E+03	1,044E+03				
900.00	2,149E+01	1,655E-01	5,476E+04	1,637E-05	5,019E+05	7,478E-09	2,688E+04	2,688E+04	6,608E-04	1,266E-03
	7,484E-03	8,261E+00	1,045E-09	1,473-125	5,698-142	1,932E-53	2,705E+04	2,705E+04	7,889E-04	5,306E-04
	8,023E-08	-6,146E-08	4,791E-18	1,507E+02	1,044E+03	1,044E+03				
920.00	1,324E+01	9,512E-02	4,152E+04	8,202E-06	4,683E+05	3,493E-09	2,432E+04	2,432E+04	4,446E-04	1,035E-03
	4,610E-03	5,952E+00	5,388E-10	7,261-129	1,161-145	6,983E-55	2,446E+04	2,446E+04	5,575E-04	7,525E-04
	7,348E-08	-4,461E-08	4,216E-18	1,623E+02	1,044E+03	1,044E+03				
940.00	8,174E+00	5,485E-02	3,153E+04	4,125E-06	4,371E+05	1,638E-09	2,201E+04	2,201E+04	3,021E-04	8,468E-04
	2,847E-03	4,289E+00	2,778E-10	3,578-132	2,367-149	2,525E-56	2,213E+04	2,213E+04	4,022E-04	1,065E-03
	6,755E-08	-3,217E-08	3,743E-18	1,743E+02	1,044E+03	1,044E+03				
960.00	5,062E+00	3,173E-02	2,398E+04	2,083E-06	4,082E+05	7,714E-10	1,991E+04	1,991E+04	2,072E-04	6,928E-04
	1,763E-03	3,091E+00	1,432E-10	1,764-135	4,825-153	9,127E-58	2,002E+04	2,002E+04	2,966E-04	1,505E-03
	6,229E-08	-2,307E-08	3,350E-18	1,865E+02	1,044E+03	1,044E+03				
980.00	3,142E+00	1,841E-02	1,826E+04	1,055E-06	3,813E+05	3,648E-10	1,802E+04	1,802E+04	1,434E-04	5,668E-04
	1,094E-03	2,227E+00	7,381E-11	8,692-139	9,835-157	3,300E-59	1,811E+04	1,811E+04	2,242E-04	2,120E-03
	5,759E-08	-1,647E-08	3,020E-18	1,987E+02	1,044E+03	1,044E+03				
1000.00	1,956E+00	1,071E-02	1,393E+04	5,367E-07	3,563E+05	1,732E-10	1,630E+04	1,630E+04	1,001E-04	4,638E-04
	6,812E-04	1,605E+00	3,805E-11	4,284-142	2,005-160	1,193E-60	1,638E+04	1,638E+04	1,741E-04	2,979E-03
	5,337E-08	-1,171E-08	2,739E-18	2,107E+02	1,044E+03	1,044E+03				
1040.00	7,636E-01	3,657E-03	8,142E+03	1,404E-07	3,115E+05	3,952E-11	1,335E+04	1,335E+04	4,991E-05	3,105E-04
	2,660E-04	8,337E-01	1,011E-11	1,040-148	8,328-168	1,559E-63	1,341E+04	1,341E+04	1,156E-04	5,833E-03
	4,607E-08	-5,877E-09	2,287E-18	2,332E+02	1,044E+03	1,044E+03				
1080.00	3,012E-01	1,264E-03	4,785E+03	3,724E-08	2,727E+05	9,163E-12	1,093E+04	1,093E+04	2,555E-05	2,080E-04
	1,049E-04	4,330E-01	2,687E-12	2,527-155	3,460-175	2,038E-66	1,097E+04	1,097E+04	8,956E-05	1,129E-02
	4,000E-08	-2,930E-09	1,940E-18	2,528E+02	1,044E+03	1,044E+03				
1120.00	1,200E-01	4,415E-04	2,829E+03	1,002E-08	2,391E+05	2,158E-12	8,948E+03	8,948E+03	1,336E-05	1,393E-04
	4,178E-05	2,249E-01	7,142E-13	6,138-162	1,438-182	2,664E-69	8,978E+03	8,978E+03	8,212E-05	2,159E-02
	3,487E-08	-1,457E-09	1,665E-18	2,693E+02	1,044E+03	1,044E+03				
1160.00	4,825E-02	1,560E-04	1,682E+03	2,735E-09	2,100E+05	5,159E-13	7,326E+03	7,326E+03	7,115E-06	9,331E-05
	1,681E-05	1,168E-01	1,898E-13	1,491-168	5,972-190	3,482E-72	7,347E+03	7,347E+03	8,745E-05	4,082E-02
	3,050E-08	-7,254E-10	1,440E-18	2,827E+02	1,044E+03	1,044E+03				
1200.00	1,960E-02	5,574E-05	1,005E+03	7,566E-10	1,846E+05	1,253E-13	5,998E+03	5,998E+03	3,843E-06	6,251E-05
	6,825E-06	6,070E-02	5,044E-14	3,621-175	2,481-197	4,550E-75	6,013E+03	6,013E+03	1,034E-04	7,622E-02
	2,675E-08	-3,621E-10	1,254E-18	2,936E+02	1,044E+03	1,044E+03				

END OF TEST PROBLEM

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